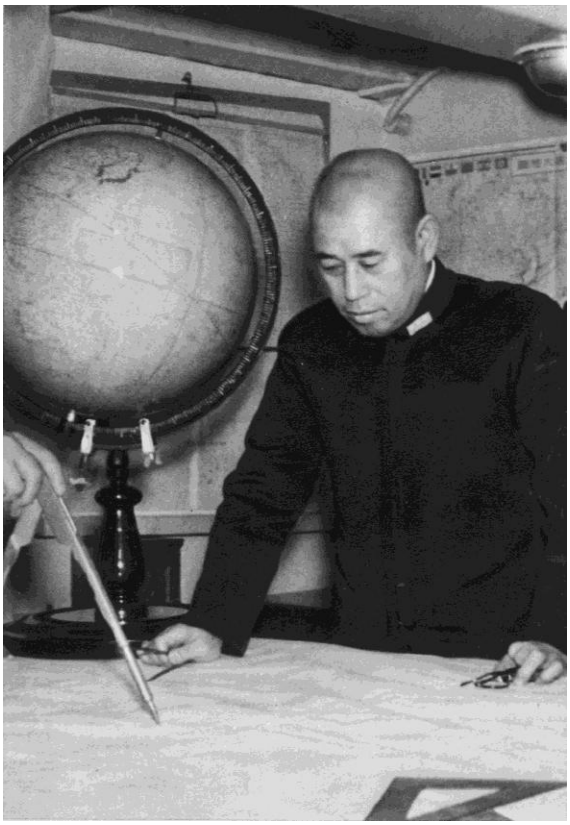
PAUL CUFFEE SCHOOL
A Maritime Charter School for Providence Youth

9TH Grade Mathematics Curriculum

Captain Thomas R. Beall, U. S. Navy (Ret.)

Volume III
Third Trimester



PAUL CUFFEE SCHOOL
A Maritime Charter School for Providence Youth

Mathematics and History

The Battle of Midway, 1942

9th Grade Mathematics Final Project

Thomas R. Beall
Captain, U. S. Navy (Ret.)

9th Grade Final Project: Mathematics and History

I. **Background.** The final project will be in multiple parts and will be completed over the next three months. The project will fall under a historical scenario that will unfold as each part is given to you.

II. **Format.** Each part will include instructions, some of the required materials, and all the information you will need to complete that part. It will be necessary to complete each part to move on to the next part because the answers to each part will be required when working on the next part.

III. **Grading.** This project will make up one half of your final course grade. If you do not complete all parts, you will not pass the third trimester of 9th grade mathematics.

Dear Paul Cuffee 9th Grade Parent,

With the start of the Third Trimester, your son or daughter will begin the 9th Grade Final Mathematics Project. This project is in several parts, called tasks, each of which is an assignment designed to challenge him or her to put the mathematics skills learned this year to practical use. It is also designed to help your son or daughter build the self – confidence and resiliency to take on and complete challenging tasks on a fixed deadline. It is, therefore, very important that your son or daughter complete each part by its due date.

The Final Mathematics Project brings together history and mathematics by exploring the geography, ships, and men involved in the World War II Naval Battle of Midway. In June of 1942, two great fleets, one Japanese and one American, clashed near the small island of Midway in the Central Pacific Ocean. Both sides realized that the outcome of the Pacific War might depend on the outcome of this battle. To gain an advantage, each side applied mathematical techniques to all aspects of the battle, techniques which your son or daughter will have the opportunity to practice. The project concludes with a four – day war game played by all students to refight the battle. We also commemorate the anniversary of the battle (June 4th) with a guest speaker and a celebratory cake.

Attached to this letter is a list of all project tasks and the dates they are due to me. Late submission will result in assignment of a grade one level lower than otherwise would have been assigned for the work completed. Please ensure your son or daughter completes assigned tasks on time.

Please feel free to contact me with any questions or concerns. My e-mail address is tbeall@paulcuffee.org.

Sincerely,

Thomas R. Beall
Captain, U. S. Navy (Ret.)
Ninth Grade Mathematics Teacher

Estimado Padre/Encargado de 9no Grado del Escuela Paul Cuffee,

Con el inicio del tercer trimestre, su hijo o hija comenzará el Proyecto Final de Matemáticas de 9no Grado. Este proyecto consta de varias partes, llamadas tareas, cada una de las cuales está diseñada para retarlo(a) a poner las habilidades matemáticas aprendidas este año en uso práctico. El proyecto también está diseñado para ayudar a su hijo(a) a desarrollar confianza en sí mismo(a) y flexibilidad para asumir y completar tareas difíciles en un plazo determinado. Es, por lo tanto, muy importante que su hijo(a) complete cada parte en la fecha de entrega.

El Proyecto Final de Matemáticas reúne la historia y las matemáticas mediante la exploración de la geografía, los barcos y los personajes involucrados en la Batalla Naval de Midway en la Segunda Guerra Mundial. En junio de 1942, dos grandes flotas, una japonesa y una estadounidense, se enfrentaron cerca de la pequeña isla de Midway, en el Océano Pacífico Central. Ambas partes se dieron cuenta de que el resultado de la Guerra del Pacífico podría depender del resultado de esta batalla. Para obtener una ventaja, cada parte aplicó técnicas matemáticas en todos los aspectos de la batalla, técnicas que su hijo(a) tendrá la oportunidad de practicar. El proyecto concluye con un juego de guerra de cuatro días interpretado por todos los estudiantes para revivir la batalla. También conmemoramos el aniversario de la batalla (4 de junio) con un invitado y un pastel de celebración.

Adjunto, encontrará una lista de todas las tareas del proyecto y las fechas en que deben ser entregadas. La entrega tarde de cualquier tarea resultará en un grado más bajo del que le hubiera sido asignado por el trabajo realizado. Por favor asegúrese de que su hijo(a) termine las tareas asignadas a tiempo.

Por favor, no dude en ponerse en contacto conmigo con cualquier pregunta o preocupación. Mi dirección de correo electrónico es tbeall@paulcuffee.org.

Atentamente,

Thomas R. Beall
Capitán, U. S. Marina (Ret.)
Maestro de Matemáticas de Noveno Grado

Ninth Grade Final Mathematics Project
Task Completion Checklist

Complete only those tasks assigned to your class (Algebra I or Geometry)

Task	Class	Date Due	Done?
1. Breaking the Code	Algebra I Geometry		
2. Staying Power / Firepower System of Equations	Algebra I		
3. 16 inch Gun Data Analysis	Geometry		
4. Warship Survivability Data Analysis	Algebra I Geometry		
5. Ship Stability Problems.	Geometry		
6. Battleship *Massachusetts* Scaled Drawing.	Algebra I Geometry		
7. Maneuvering Board Exercise	Geometry		
8. Battleship *Massachusetts* Scale Model	Algebra I		
9. Battleship *Massachusetts* Field Trip Assignment and Reflection	Algebra I Geometry		
10. Communications Signals Exercise	Algebra I Geometry		
11. War Game Map	Algebra I Geometry		
12. War Game	Algebra I Geometry		

PAUL CUFFEE SCHOOL
A Maritime Charter School for Providence Youth

9th Grade Mathematics
Final Project

Student Name: _____

Final Grade: _____

Task	Standards	Complete
1. Breaking the Code	M(N&O)–10–2 M(N&O)–10–8	
2. Staying Power / Firepower System of Equations	M(F&A)–10–2 M(F&A)–10–3	
3. 16 in. Gun Data Analysis	M(G&M)–10–2	
4. Warship Survivability Data Analysis	M(G&M)–10–9 M(F&A)–10–1 M(F&A)–10–2 M(F&A)–10–4 M(DSP)–10–1 M(DSP)–10–2	
5. Ship Stability Problems	M(G&M)–10–2	
6. Battleship *Massachusetts* Scaled Drawing	M(G&M)–10–5 M(G&M)–10–7 M(G&M)–10–9	
7. Maneuvering Board Exercise	M(G&M)–10–6	
8. Battleship *Massachusetts* Scale Model	M(G&M)–10–4 M(G&M)–10–10	
9. Field Trip Reflection		
10. Communication Signals Exercise		
11. War Game Map	M(G&M)–10–5 M(G&M)–10–7	
12. War Game	M(G&M)–10–7	

Historical Background[1]

The Battle of Midway, fought over and near the tiny U.S. mid-Pacific base at Midway atoll, represents the strategic high water mark of Japan's Pacific Ocean war. Prior to this action, Japan possessed general naval superiority over the United States and could usually choose where and when to attack. After Midway, the two opposing fleets were essentially equals, and the United States soon took the offensive.

Japanese Combined Fleet commander Admiral Isoroku Yamamoto moved on Midway in an effort to draw out and destroy the U.S. Pacific Fleet's aircraft carrier striking forces, which had embarrassed the Japanese Navy in the mid-April Doolittle Raid on Japan's home islands and at the Battle of Coral Sea in early May. He planned to quickly knock down Midway's defenses, follow up with an invasion of the atoll's two small islands and establish a Japanese air base there. He expected the U.S. carriers to come out and fight, but to arrive too late to save Midway and in insufficient strength to avoid defeat by his own well-tested carrier air power.

Yamamoto's intended surprise was thwarted by superior American communications intelligence, which deduced his scheme well before battle was joined. This allowed Admiral Chester W. Nimitz, the U.S. Pacific Fleet commander, to establish an ambush by having his carriers ready and waiting for the Japanese. On 4 June 1942, in the second of the Pacific War's great carrier battles, the trap was sprung. The perseverance, sacrifice and skill of U.S. Navy aviators, plus a great deal of good luck on the American side, cost Japan four irreplaceable fleet carriers, while only one of the three U.S. carriers present was lost. The base at Midway, though damaged by Japanese air attack, remained operational and later became a vital component in the American trans-Pacific offensive.

[1] Source: Naval History and Heritage Command. Accessed online 15 April 2012 at http://www.history.navy.mil/photos/events/wwii-pac/midway/midway.htm.

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V. Appendices

P. Preliminary Review and Instruction P – 1

Part I: Numbers and Operations – Breaking the Code

Teacher Notes

Objectives:

1. Recognize patterns in number sequences.
2. Identify arithmetic operations performed on a sequence of numbers.
3. Develop self-confidence and resiliency by completing a challenging and unfamiliar task in which all steps may not be clearly identified.

Teacher Support:

1. The encoded message, when decoded, reads as follows:

   FM COMMANDER COMBINED FLEET
   TO COMMANDER CARRIER STRIKE FLEET
   SUBJECT: MIDWAY OPERATION
   MIDWAY ISLAND WILL BE ATTACKED ON JUNE FOURTH
   MIDWAY ISLAND IS LOCATED AT 28°13' N 177°22'W.
   THE CARRIER STRIKE FLEET WILL LEAD THE ATTACK.
   YOU WILL HAVE FOUR AIRCRAFT CARRIERS.
   KAGA
   AKAGI
   HIRYU
   SORYU
   YOU WILL BE PREPARED TO ATTACK AND DESTROY
   UNITED STATES NAVAL FORCES DEFENDING MIDWAY.

2. Each student has received an encoded message in which each letter has been translated to its number equivalent and then subjected to another arithmetic operation which is the same for all letters in the message. For example:

   a. $Letter\ "B" = 2$
   b. $2^2 = 4$ so the number that corresponds to "B" in the encoded message is 4.

3. There are seven versions of the encoded message. Each student received one version. The multiple versions are designed to discourage student copying.

4. In each of the seven versions, I performed a single arithmetic operation on all of the numbers which correspond to letters. You can identify the version because it is listed on the page with the code in the bottom right-hand corner. The operations in the different versions are as follows:

    a. Version 1 (v.1): Numbers raised to the second power.
    b. Version 2 (v.2): Numbers raised to the third power.
    c. Version 3 (v.3): Numbers reduced to their square roots.
    d. Version 4 (v.4): Numbers multiplied by "5".
    e. Version 5 (v.5): Numbers divided by "2".
    f. Version 6 (v.6): The number "7" added to each number.
    g. Version 7 (v.7): The number "13" added to each number.

5. Since one of the primary objectives in this task and all tasks of this project is to develop student self-confidence and resiliency, teachers should be judicious in the amount of support provided to students. Many will undoubtedly ask for as much as they can get. Teachers should ensure that the help provided is only in accordance with documented needs.

Name: _____

9th Grade Final Project: Mathematics and History

Part I: Numbers and Operations – Breaking the Code

1. **Standards: M(N&O)–10–2 M(N&O)–10–8.**

2. **Historical Background.** In the Second World War, all the combatant powers translated all of their radio and written messages into a code (a process called encryption) to keep the contents of their messages secret from their enemies.

   Of course, each combatant tried to break his enemy's codes and all combatants succeeded to some degree. One of the most famous code breaking efforts was conducted by the United States armed forces against the Empire of Japan during the Pacific War (1941 - 1945). American code breakers managed to read enough of the Japanese codes to know, after early 1942, what the Japanese military was planning against American forces.

3. **Code - breaking Techniques.** All code - breakers (called cryptanalysts) used common techniques for breaking codes. Among those techniques which you might find useful in performing this task are:

   a. Look for numbers that occur most frequently. The letter "E" is the most frequently occurring letter in the English language (and many other languages). The most frequently occurring number often (though not always) represents the letter "E".

   b. Look for repeated number sequences. Many words are used more than once in most written messages. Look for identical number sequences. They will often represent the same word.

   c. One number occurs most frequently but look carefully at where it occurs. It should indicate that it is used for only one thing.

4. **Scenario.** It is May 1st, 1942. Last December, the Imperial Japanese Navy's Combined Fleet attacked the U.S. Pacific Fleet at its base in Pearl Harbor, Hawaii, destroying many ships and killing many men. Since then, the United States has been at war with the Empire of Japan. During

these months, the Japanese have conquered many islands and territories in the Pacific Ocean. Admiral Chester W. Nimitz, the Commander in Chief of the U.S. Pacific Fleet, is trying to figure out where Japan's next major attack will be. American naval code - breakers are assisting him by breaking Japanese secret codes and providing the information in them to members of Nimitz' staff.

5. **Assignment.** On the next page is a Japanese coded message with some hints about it. You are to break the code and turn in the decoded message, ***typewritten***, no later than_____**.**

6. **Note:** Not all students received the same encoded message. If you do not do your own work, you may get an incorrect answer and will get no credit.

Coded Message

1. Each number corresponds to one and only one letter of the alphabet.
2. In developing this code I started with the basic table below and then made some further arithmetic changes (in other words, I may have added to, subtracted from, raised to a power, multiplied or divided the numbers from the basic table). I made the same change to each number.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

3. The number which appears most often has a special significance.
4. Numbers in quotation marks should be read as the actual number, not a coded letter.
5. Each line represents a line of text.

Getting Started:

1. Find the number that occurs the second most often. That number most likely represents "A" or "E".
2. Determine what mathematical operation you need to perform on that number to make it equal "1" (for "A") or "5" (for "E").
3. Perform the same operation on all other numbers except the one that occurs most often.
4. See if the numbers now represent the letters in the table above. If they do, you have broken the code.

36	169	0	9	225	169	169	1	196	16	25	324	0	9	225	169	4	81	196	25	16	0	36	144	25	25	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
400	225	0	9	225	169	169	1	196	16	25	324	0	9	1	324	324	81	25	324	0	361	400	324	81	121	25	0	36	144	25	25	400	0	0	0	0	0	0	0	0	0	0	0
361	441	4	100	25	9	400	:	0	169	81	16	529	1	625	0	225	256	25	324	1	400	81	225	196	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
169	81	16	529	1	625	0	81	361	144	1	196	16	0	529	81	144	144	0	4	25	0	1	400	400	1	9	121	25	16	0	225	196	0	100	441	196	25	0	36	225	441	324	400	64	.
169	81	16	529	1	625	0	81	361	144	1	196	16	0	81	361	0	144	225	9	1	400	25	16	0	1	400	0	28°13'	196	0	177°22'	529	.	0	0	0	0	0	0	0	0	0	0	0
400	64	25	0	9	1	324	324	81	25	324	0	361	400	324	81	121	25	0	36	144	25	25	400	0	529	81	144	144	0	144	25	1	16	0	400	64	25	0	1	400	400	1	9	121	.
625	225	441	0	529	81	144	144	0	64	1	484	25	0	36	225	441	324	0	1	81	324	9	324	1	36	400	0	9	1	324	324	81	25	324	361	0	0	0	0	0	0	0	0	0	0
121	1	49	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	121	1	49	81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	81	324	625	441	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
361	225	324	625	441	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
625	225	441	0	529	81	144	144	0	4	25	0	256	324	25	256	1	324	25	16	0	400	225	0	1	400	400	1	9	121	0	1	196	16	0	16	25	361	400	324	225	625	0	0	0	0
441	196	81	400	25	16	0	361	400	1	400	25	361	0	196	1	484	1	144	0	36	225	324	9	25	361	0	16	25	36	25	196	16	81	196	49	0	169	81	16	529	1	625	.	0	0

v.1

Coded Message

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A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

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216	2197	0	27	3375	2197	2197	1	2744	64	125	5832	0	27	3375	2197	8	729	2744	125	64	0	216	1728	125	125	8000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8000	3375	0	27	3375	2197	2197	1	2744	64	125	5832	0	27	1	5832	5832	729	125	5832	0	6859	8000	5832	729	1331	125	0	216	1728	125	125	8000	0	0	0	0	0	0	0	0	0	0
6859	9261	8	1000	125	27	8000	:	0	2197	729	64	12167	1	15625	0	3375	4096	125	5832	1	8000	729	3375	2744	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2197	729	64	12167	1	15625	0	729	6859	1728	1	2744	64	0	12167	729	1728	1728	0	8	125	0	1	8000	8000	1	27	1331	125	64	0	3375	2744	0	1000	9261	2744	125	0	216	3375	9261	5832	8000	512	.
2197	729	64	12167	1	15625	0	729	6859	1728	1	2744	64	0	729	6859	0	1728	3375	27	1	8000	125	64	0	1	8000	0	28°13'	2744	0	177°22'	12167	.	0	0	0	0	0	0	0	0	0	0	0
8000	512	125	0	27	1	5832	5832	729	125	5832	0	6859	8000	5832	729	1331	125	0	216	1728	125	125	8000	0	12167	729	1728	1728	0	1728	125	1	64	0	8000	512	125	0	1	8000	8000	1	27	1331	.
15625	3375	9261	0	12167	729	1728	1728	0	512	1	10648	125	0	216	3375	9261	5832	0	1	729	5832	27	5832	1	216	8000	0	27	1	5832	5832	729	125	5832	6859	0	0	0	0	0	0	0	0	0	0
1331	1	343	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1331	1	343	729	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
512	729	5832	15625	9261	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6859	3375	5832	15625	9261	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15625	3375	9261	0	12167	729	1728	1728	0	8	125	0	4096	5832	125	4096	1	5832	125	64	0	8000	3375	0	1	8000	8000	1	27	1331	0	1	2744	64	0	64	125	6859	8000	5832	3375	15625	0	0	0	0
9261	2744	729	8000	125	64	0	6859	8000	1	8000	125	6859	0	2744	1	10648	1	1728	0	216	3375	5832	27	125	6859	0	64	125	216	125	2744	64	729	2744	343	0	2197	729	64	12167	1	15625	.	0	0

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2.449	3.606	0	1.732	3.873	3.606	3.606	1	3.742	2	2.236	4.243	0	1.732	3.873	3.606	1.414	3	3.742	2.236	2	0	2.449	3.464	2.236	2.236	4.472	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.472	3.873	0	1.732	3.873	3.606	3.606	1	3.742	2	2.236	4.243	0	1.732	1	4.243	4.243	3	2.236	4.243	0	4.359	4.472	4.243	3	3.317	2.236	0	2.449	3.464	2.236	2.236	4.472	0	0	0	0	0	0	0	0	0	0	0	0
4.359	4.583	1.414	3.162	2.236	1.732	4.472	:	0	3.606	3	2	4.796	1	5	0	3.873	4	2.236	4.243	1	4.472	3	3.873	3.742	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.606	3	2	4.796	1	5	0	3	4.359	3.464	1	3.742	2	0	4.796	3	3.464	3.464	0	1.414	2.236	0	1	4.472	4.472	1	1.732	3.317	2.236	2	0	3.873	3.742	0	3.162	4.583	3.742	2.236	0	2.449	3.873	4.583	4.243	4.472	2.828	.
3.606	3	2	4.796	1	5	0	3	4.359	3.464	1	3.742	2	0	3	4.359	0	3.464	3.873	1.732	1	4.472	2.236	2	0	1	4.472	0	28°13'	3.742	0	177°22'	4.796	.	0	0	0	0	0	0	0	0	0	0	0	0
4.472	2.828	2.236	0	1.732	1	4.243	4.243	3	2.236	4.243	0	4.359	4.472	4.243	3	3.317	2.236	0	2.449	3.464	2.236	2.236	4.472	0	4.796	3	3.464	3.464	0	3.464	2.236	1	2	0	4.472	2.828	2.236	0	1	4.472	4.472	1	1.732	3.317	.
5	3.873	4.583	0	4.796	3	3.464	3.464	0	2.828	1	4.69	2.236	0	2.449	3.873	4.583	4.243	0	1	3	4.243	1.732	4.243	1	2.449	4.472	0	1.732	1	4.243	4.243	3	2.236	4.243	4.359	0	0	0	0	0	0	0	0	0	0
3.317	1	2.646	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	3.317	1	2.646	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.828	3	4.243	5	4.583	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.359	3.873	4.243	5	4.583	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	3.873	4.583	0	4.796	3	3.464	3.464	0	1.414	2.236	0	4	4.243	2.236	4	1	4.243	2.236	2	0	4.472	3.873	0	1	4.472	4.472	1	1.732	3.317	0	1	3.742	2	0	2	2.236	4.359	4.472	4.243	3.873	5	0	0	0	0
4.583	3.742	3	4.472	2.236	2	0	4.359	4.472	1	4.472	2.236	4.359	0	3.742	1	4.69	1	3.464	0	2.449	3.873	4.243	1.732	2.236	4.359	0	2	2.236	2.449	2.236	3.742	2	3	3.742	2.646	0	3.606	3	2	4.796	1	5	.	0	0

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A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

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30	65	0	15	75	65	65	5	70	20	25	90	0	15	75	65	10	45	70	25	20	0	30	60	25	25	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	75	0	15	75	65	65	5	70	20	25	90	0	15	5	90	90	45	25	90	0	95	100	90	45	55	25	0	30	60	25	25	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
95	105	10	50	25	15	100	:	0	65	45	20	115	5	125	0	75	80	25	90	5	100	45	75	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	45	20	115	5	125	0	45	95	60	5	70	20	0	115	45	60	60	0	10	25	0	5	100	100	5	15	55	25	20	0	75	70	0	50	105	70	25	0	30	75	105	90	100	40	.			
65	45	20	115	5	125	0	45	95	60	5	70	20	0	45	95	0	60	75	15	5	100	25	20	0	5	100	0	28°13'	70	0	177°22'	115	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	40	25	0	15	5	90	90	45	25	90	0	95	100	90	45	55	25	0	30	60	25	25	100	0	115	45	60	60	0	60	25	5	20	0	100	40	25	0	5	100	100	5	15	55	.			
125	75	105	0	115	45	60	60	0	40	5	110	25	0	30	75	105	90	0	5	45	90	15	90	5	30	100	0	15	5	90	90	45	25	90	95	0	0	0	0	0	0	0	0	0	0	0	0	0
55	5	35	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	55	5	35	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	45	90	125	105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
95	75	90	125	105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
125	75	105	0	115	45	60	60	0	10	25	0	80	90	25	80	5	90	25	20	0	100	75	0	5	100	100	5	15	55	0	5	70	20	0	20	25	95	100	90	75	125	0	0	0	0	0	0	0
105	70	45	100	25	20	0	95	100	5	100	25	95	0	70	5	110	5	60	0	30	75	90	15	25	95	0	20	25	30	25	70	20	45	70	35	0	65	45	20	115	5	125	.	0	0	0	0	0

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
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3	6.5	0	1.5	7.5	6.5	6.5	0.5	7	2	2.5	9	0	1.5	7.5	6.5	1	4.5	7	2.5	2	0	3
10	7.5	0	1.5	7.5	6.5	6.5	0.5	7	2	2.5	9	0	1.5	0.5	9	9	4.5	2.5	9	0	9.5	10
9.5	10.5	1	5	2.5	1.5	10	:	0	6.5	4.5	2	11.5	0.5	12.5	0	7.5	8	2.5	9	0.5	10	4.5
6.5	4.5	2	11.5	0.5	12.5	0	4.5	9.5	6	0.5	7	2	0	11.5	4.5	6	6	0	1	2.5	0	0.5
6.5	4.5	2	11.5	0.5	12.5	0	4.5	9.5	6	0.5	7	2	0	4.5	9.5	0	6	7.5	1.5	0.5	10	2.5
10	4	2.5	0	1.5	0.5	9	9	4.5	2.5	9	0	9.5	10	9	4.5	5.5	2.5	0	3	6	2.5	2.5
12.5	7.5	10.5	0	11.5	4.5	6	6	0	4	0.5	11	2.5	0	3	7.5	10.5	9	0	0.5	4.5	9	1.5
5.5	0.5	3.5	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.5	5.5	0.5	3.5	4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	4.5	9	12.5	10.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.5	7.5	9	12.5	10.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.5	7.5	10.5	0	11.5	4.5	6	6	0	1	2.5	0	8	9	2.5	8	0.5	9	2.5	2	0	10	7.5
10.5	7	4.5	10	2.5	2	0	9.5	10	0.5	10	2.5	9.5	0	7	0.5	11	0.5	6	0	3	7.5	9

6	2.5	2.5	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	4.5	5.5	2.5	0	3	6	2.5	2.5	10	0	0	0	0	0	0	0	0	0	0	0	0	0
7.5	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	10	0.5	1.5	5.5	2.5	2	0	7.5	7	0	5	10.5	7	2.5	0	3	7.5	10.5	9	10	4	.
2	0	0.5	10	0	28°13'	7	0	177°22'	11.5	.	0	0	0	0	0	0	0	0	0	0	0	0
10	0	11.5	4.5	6	6	0	6	2.5	0.5	2	0	10	4	2.5	0	0.5	10	10	0.5	1.5	5.5	.
9	0.5	3	10	0	1.5	0.5	9	9	4.5	2.5	9	9.5	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.5	10	10	0.5	1.5	5.5	0	0.5	7	2	0	2	2.5	9.5	10	9	7.5	12.5	0	0	0	0
1.5	2.5	9.5	0	2	2.5	3	2.5	7	2	4.5	7	3.5	0	6.5	4.5	2	11.5	0.5	12.5	.	0	0

v.5

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13	20	7	10	22	20	20	8	21	11	12	25	7	10	22	20	9	16	21	12	11	7	13	19	12	12	27	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
27	22	7	10	22	20	20	8	21	11	12	25	7	10	8	25	25	16	12	25	7	26	27	25	16	18	12	7	13	19	12	12	27	7	7	7	7	7	7	7	7	7	7
26	28	9	17	12	10	27	:	7	20	16	11	30	8	32	7	22	23	12	25	8	27	16	22	21	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
20	16	11	30	8	32	7	16	26	19	8	21	11	7	30	16	19	19	7	9	12	7	8	27	27	8	10	18	12	11	7	22	21	7	17	28	21	12	7	13	22	28	25	27	15	.
20	16	11	30	8	32	7	16	26	19	8	21	11	7	16	26	7	19	22	10	8	27	12	11	7	8	27	7	28°13'	21	7	177°22'	30	.	7	7	7	7	7	7	7	7	7	7	7	7
27	15	12	7	10	8	25	25	16	12	25	7	26	27	25	16	18	12	7	13	19	12	12	27	7	30	16	19	19	7	19	12	8	11	7	27	15	12	7	8	27	27	8	10	18	.
32	22	28	7	30	16	19	19	7	15	8	29	12	7	13	22	28	25	7	8	16	25	10	25	8	13	27	7	10	8	25	25	16	12	25	26	7	7	7	7	7	7	7	7	7	7
18	8	14	8	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
8	18	8	14	16	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
15	16	25	32	28	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
26	22	25	32	28	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
32	22	28	7	30	16	19	19	7	9	12	7	23	25	12	23	8	25	12	11	7	27	22	7	8	27	27	8	10	18	7	8	21	11	7	11	12	26	27	25	22	32	7	7	7	7
28	21	16	27	12	11	7	26	27	8	27	12	26	7	21	8	29	8	19	7	13	22	25	10	12	26	7	11	12	13	12	21	11	16	21	14	7	20	16	11	30	8	32	.	7	7

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19	26	13	16	28	26	26	14	27	17	18	31	13	16	28	26	15	22	27	18	17	13	19	25	18	18	33	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
33	28	13	16	28	26	26	14	27	17	18	31	13	16	14	31	31	22	18	31	13	32	33	31	22	24	18	13	19	25	18	18	33	13	13	13	13	13	13	13	13	13	13	13
32	34	15	23	18	16	33	:	13	26	22	17	36	14	38	13	28	29	18	31	14	33	22	28	27	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
26	22	17	36	14	38	13	22	32	25	14	27	17	13	36	22	25	25	13	15	18	13	14	33	33	14	16	24	18	17	13	28	27	13	23	34	27	18	13	19	28	34	31	33	21	.
26	22	17	36	14	38	13	22	32	25	14	27	17	13	22	32	13	25	28	16	14	33	18	17	13	14	33	13	28°13'	27	13	177°22'	36	.	13	13	13	13	13	13	13	13	13	13
33	21	18	13	16	14	31	31	22	18	31	13	32	33	31	22	24	18	13	19	25	18	18	33	13	36	22	25	25	13	25	18	14	17	13	33	21	18	13	14	33	33	14	16	24	.
38	28	34	13	36	22	25	25	13	21	14	35	18	13	19	28	34	31	13	14	22	31	16	31	14	19	33	13	16	14	31	31	22	18	31	32	13	13	13	13	13	13	13	13	13	13
24	14	20	14	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
14	24	14	20	22	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
21	22	31	38	34	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
32	28	31	38	34	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
38	28	34	13	36	22	25	25	13	15	18	13	29	31	18	29	14	31	18	17	13	33	28	13	14	33	33	14	16	24	13	14	27	17	13	17	18	32	33	31	28	38	13	13	13	13
34	27	22	33	18	17	13	32	33	14	33	18	32	13	27	14	35	14	25	13	19	28	31	16	18	32	13	17	18	19	18	27	17	22	27	20	13	26	22	17	36	14	38	.	13	13

Name:_____

9th Grade Final Project: Mathematics and History

Part II: Data Analysis, Mathematical Modeling, and Prediction: Determining the Warfare Requirements

1. **Historical Background.** Warships such as U.S.S. *Massachusetts* (BB 59) and those that fought at the Battle of Midway were built as a result of compromises. An ideal warship would be faster, more powerful, and more resistant to damage than any other ship of her type. Unfortunately, such a ship would be too expensive to build. Builders, therefore, had to work within a budget, striking the right balance between what we will call ***staying power*** (a function of the ship's resistance to damage from attack and including armor and speed) and ***firepower*** (a function of how much, how fast, how far, and how accurately she could deliver explosive power to an enemy ship).

Task II A – A – Finding the Right Mix of Staying Power and Firepower
Teacher Notes

Standards: M(F&A)–10–2, M(F&A)–10–3

Objectives:

1. Correctly identify the variables of a system of equations embedded in a word problem.
2. Express the system as described in a word problem as two equations with two unknown variables.
3. Solve the system using all five methods.
4. Develop self-confidence and resiliency by completing a challenging and unfamiliar task in which all steps may not be clearly identified.

Teacher Support:

1. The correct variables are (students may use whatever symbols they choose as long as they are used consistently):

   $sp = staying\ power\ units$
   $fp = firepower\ units$

2. The correct equations and the solutions are:

   $sp + fp = 1000$
   $\$200{,}000 * sp + \$50{,}000 * fp = \$100{,}000{,}000$
   $sp = 333\ staying\ power\ units$
   $fp = 666\ staying\ power\ units$

3. The five methods of solving the system are:

   i. Elimination
   ii. Substitution
   iii. Graphing

iv. Microsoft EXCEL Program
v. Matrix Algebra

Name:_____

Task II A – A – Finding the Right Mix of Staying Power and Firepower

Standards: M(F&A)–10–2, M(F&A)–10–3

Solve the following system of equations problem using all five methods (elimination, substitution, graphing, Microsoft EXCEL program, Matrix Algebra):

To build U.S.S. *Massachusetts*, the Navy Department has offered the builder (Bethlehem Steel Corporation) $100,000,000. Building costs are determined by how many units of staying power and how many units of firepower he builds into the ship. The sum of staying power and fire power units (called the total combat power) must equal at least 1000. Each unit of staying power costs $200,000, each unit of firepower costs $50,000. How many units of staying power and how many units of firepower should the builder build into the ship to stay within the budgeted figure of $100,000,000?

1. Why do you think a unit of staying power costs more than a unit of firepower?

2. Identify the variables:

3. Write the equations:

4. Solve the system using all five methods (attach work on a separate sheets of paper).[2]

[2] *Answer:* 333 staying power units, 667 firepower units.

Task II B – G
U.S.S. *Massachusetts* 16”/45 Gun Data
Teacher Notes

Standards: M(G&M)–10–2

Objectives:

1. Correctly apply a trigonometric function to the solution of a problem.
2. Develop self-confidence and resiliency by completing a challenging and unfamiliar task in which all steps may not be clearly identified.

Teacher Support:

1. Students find the solution by applying the formula on the task sheet:

$$d = \left(\frac{v^2}{g}\right) sin2\theta$$

2. The first problem is set up as follows:

A. $d = \left(\frac{v^2}{g}\right) sin2\theta$

$$d = \left(\frac{\left(2600\left(\frac{ft}{sec}\right)\right)^2}{32\frac{f}{s^2}}\right) \times \sin(2 \times 20°)$$

$$d = 135{,}788.88\, ft = 45{,}262.96\, yards$$

B. $\% = 1 - \left(\frac{28{,}000}{45{,}262.96}\right) = 38.14\%$

Name: _____

Task II B – G
U.S.S. *Massachusetts* 16"/45 Gun Data

1. **Standards: M(G&M)–10–2**

2. The range of a projectile such as a shell fired from a gun, neglecting air resistance, is calculated by the following formula:

$$d = \left(\frac{v^2}{g}\right) sin2\theta$$

g = gravitational acceleration of $32\,\frac{f}{s^2}$.
v = the initial velocity of the projectile in feet per second.
θ = the angle of elevation of the gun.
d = the horizontal distance travelled by the projectile.

A. If the initial velocity of an armor piercing shell fired from one of *Massachusetts'* 16 – inch guns is 2600 feet per second and the angle of elevation of the gun is 20°, how far will the shell travel?

B. If air resistance reduces the range to 28,000 yards by what percent does air resistance reduce the range?

C. Perform the same calculations for the following ranges by completing this table:

Gun Elevation	Range with no air resistance	Range with air resistance	% Reduction
10°		18,000 yards	
30°		34,000 yards	
40°		38,100 yards	

Task II C – A / G – Analyzing Staying Power
Teacher Notes

Standards: M(G&M)–10–9, M(F&A)–10–1, M(F&A)–10–2, M(F&A)–10–4, M(DSP)–10–1, M(DSP)–10–2

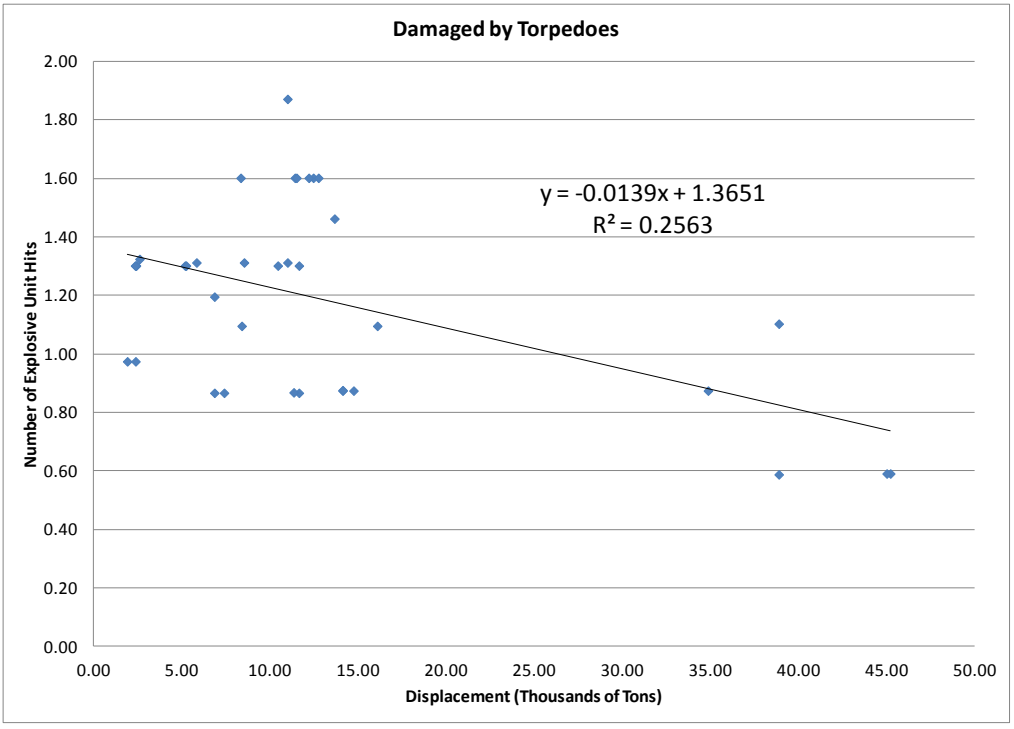
Objectives:

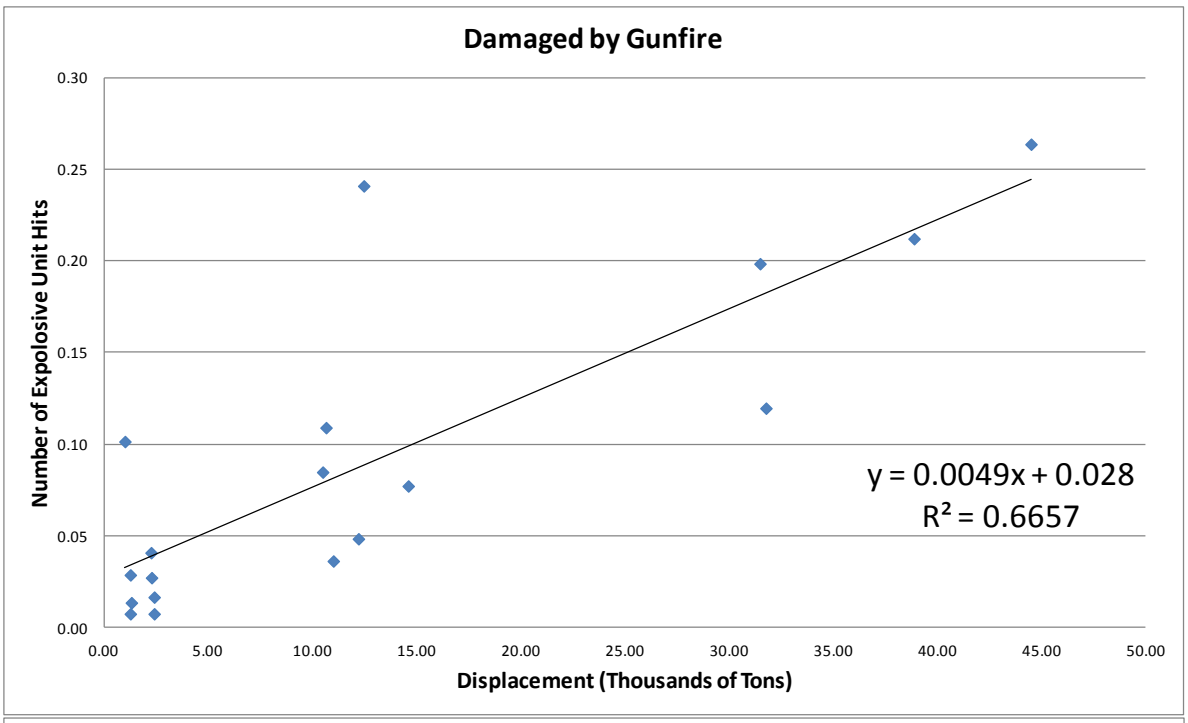
1. Accurately compile a complex data set in Microsoft EXCEL.
2. Create linear model graphs from that data, properly formatted and labeled.
3. Identify the slope and y-intercept of each linear model and use that information to conduct data analysis.
4. Understand and answer questions concerning the outcome and findings of the data analysis.
5. Develop self-confidence and resiliency by completing a challenging and unfamiliar task in which all steps may not be clearly identified.

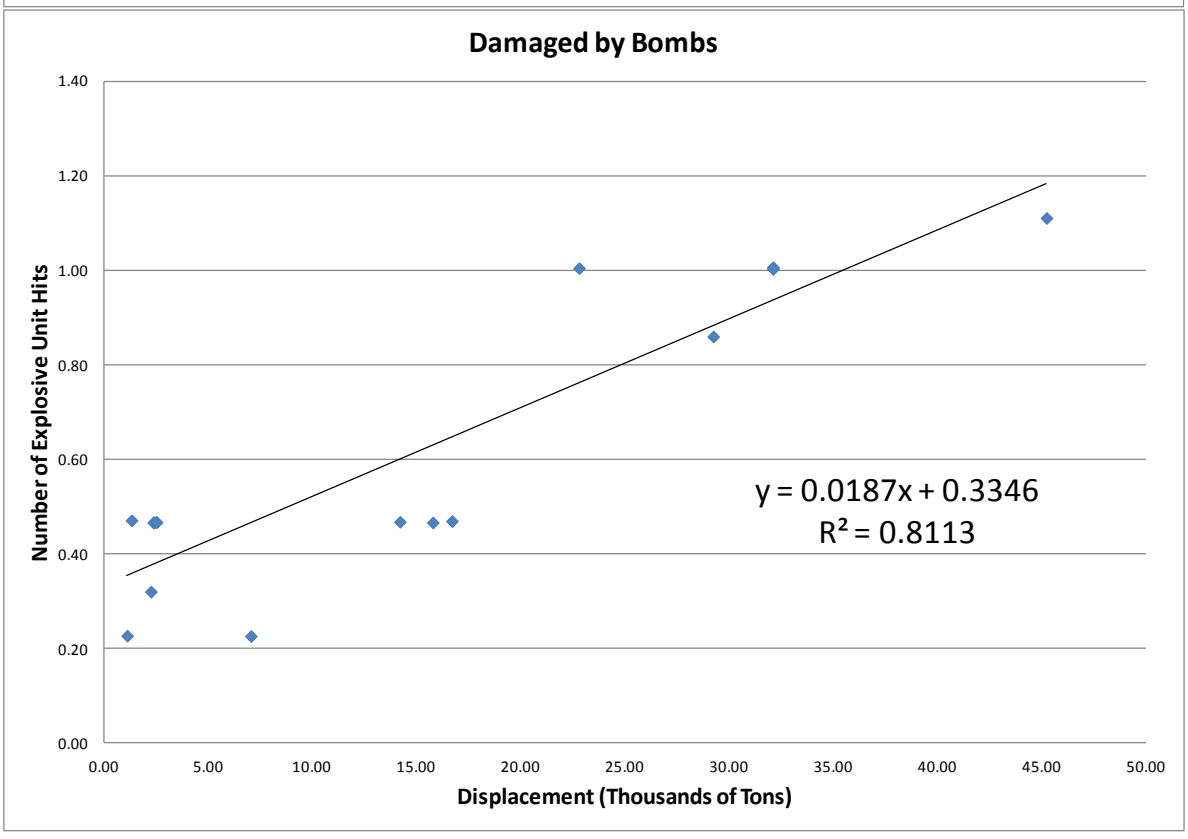
Teacher Support:

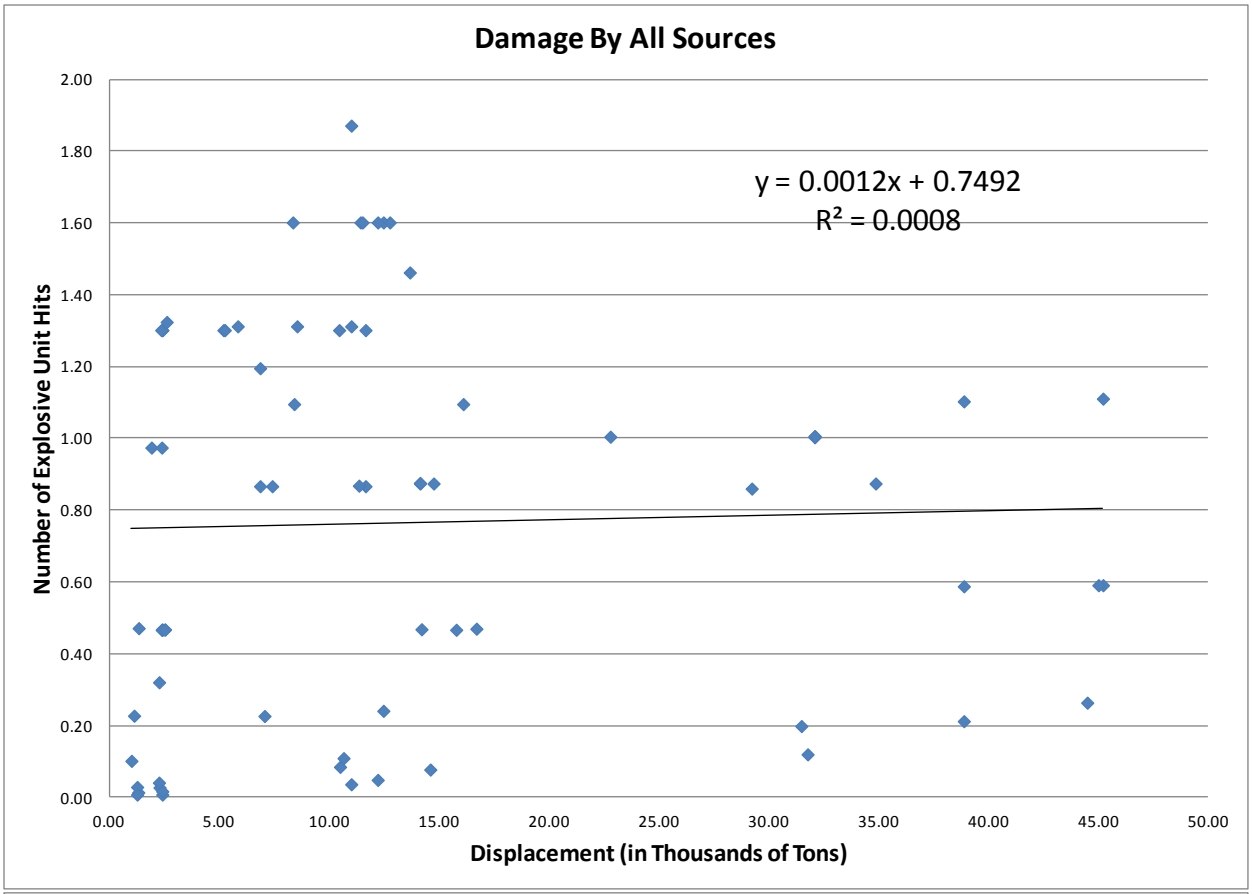
1. Students should be encouraged to fill in the table, assigning their own due dates for each milestone.

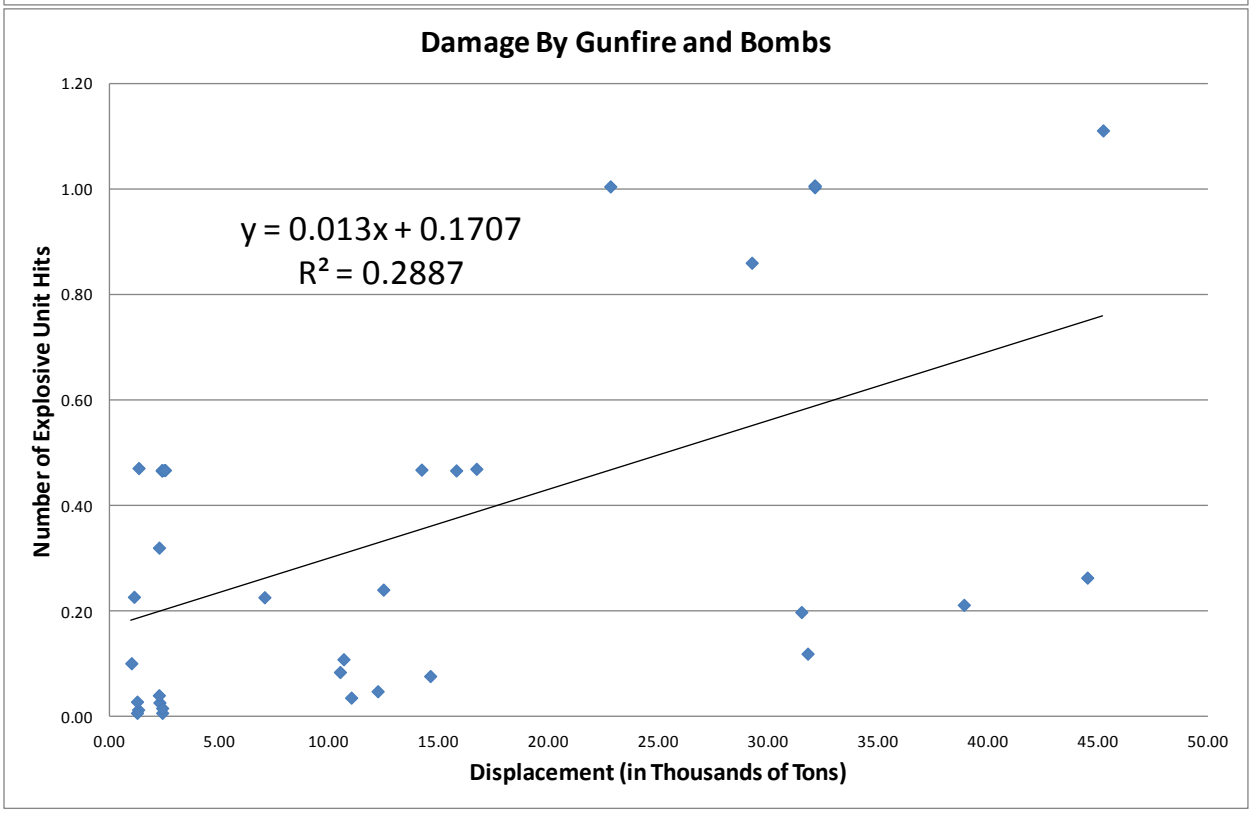
2. The five graphs should appear as below. If the equations or R^2 values differ then the student has not entered the data set correctly and should be encouraged to find the error.




Damaged by Gunfire
Number of Expolosive Unit Hits
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
Displacement (Thousands of Tons)
y = 0.0049x + 0.028
R² = 0.6657


Damaged by Bombs
Number of Explosive Unit Hits
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
Displacement (Thousands of Tons)
y = 0.0187x + 0.3346
R² = 0.8113


Damage By All Sources
y = 0.0012x + 0.7492
R² = 0.0008
Number of Explosive Unit Hits
Displacement (in Thousands of Tons)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00


Damage By Gunfire and Bombs
y = 0.013x + 0.1707
R² = 0.2887
Number of Explosive Unit Hits
Displacement (in Thousands of Tons)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00

3. To achieve the objectives, the student must correctly enter the data into EXCEL, graph it, determine the linear models and R^2 values, and prove or disprove the hypothesis: **The greater the full load displacement of a ship (a measure of how big the ship is) the more shells, bombs, or torpedoes it takes to put her out of action.**

a. The first thing the student should look for is whether the slope of the fitted line is positive or negative. A positive slope suggests a positive correlation between displacement and the number of weapons of the given type needed to put a ship out of action.

b. The second thing the student should look for is whether the R^2 value is greater than 0.5. If it is, the linear model is a good fit for the data. If not, the linear model is not a good fit and is, therefore, not useful as a predictor.

c. The conclusion the student should draw is that the two models, "Damaged by Gunfire" and "Damaged by Bombs" are useful. The others are not.

d. To exceed the standard, the student should conclude that the reason "Damaged by Torpedoes" has a slightly negative correlation is because a single torpedo will put a ship out of action regardless of the ship's size.

Task II C – A / G – Analyzing Staying Power

1. **Standards: M(G&M)–10–9, M(F&A)–10–1, M(F&A)–10–2, M(F&A)–10–4, M(DSP)–10–1, M(DSP)–10–2**

2. **Task Checklist**

Task	Date Due	Completed?
Enter data into spreadsheet. Print and attach spreadsheet.		
Compete 1st graph: Damaged by Torpedoes		
Complete 2nd graph: Damaged by Gunfire		
Complete 3rd graph: Damaged by Bombs		
Complete 4th graph: Damaged by Guns and Bombs		
Complete 5th graph: Damaged by Guns, Bombs, and Torpedoes		
Print all five graphs and attach to this paper.		
Complete table of linear equations and R^2 values on the previous page.		
Answer the question: "Of the five linear equation models, which should not be used?" in the space provided on the previous page.		
Complete Final Analysis	Mar 22nd	

3. **Historical Background.** Even before a ship like *Massachusetts* is built, the builder needs to understand how much armor and how much speed he needs to build into the ship to give her a reasonable chance of surviving in a battle. In other words, he needs to decide the minimum amount of staying power that must be built into the ship.

   To do this, he might employ mathematical analysts such as you to evaluate damage to ships from past battles in order to determine just what it took to put a ship like *Massachusetts* out of action. In World War II, the weapons used against ships were gun shells, bombs, and torpedoes. As the analyst, therefore, you might want

to look at historical data to determine how many shells, bombs, or torpedoes put ships in past battles put ships out of action.

4. **Hypothesis:** Since we are trying to figure out just what it took in terms of gun shells, bombs, or torpedoes to put a ship out of action, we need to develop a hypothesis of the relationship between a ship and the amount of damage she can take. Since it makes sense that the bigger the ship is, the greater number of shells, bombs, or torpedoes it takes to put her out of action, our hypothesis could be:

   The greater the full load displacement of a ship (a measure of how big the ship is) the more shells, bombs, or torpedoes it takes to put her out of action.

   We will test this hypothesis by analyzing data.

5. **Data.**[3] Below is the data set you will enter into a spreadsheet. It includes data on what it took to put warships out of action in World Wars I and II. It is very detailed and must be entered carefully. You can read it as follows:

   a. **Column 1** gives the names of ships that were damaged in World War I or World War II.
   b. **Column 2** gives the nationality of each ship.
   c. **Column 3** gives the full load displacement of the ship in tons. This is a measure of how big the ship is.
   d. **Column 4** gives the number of explosive units that hit the ship to put it out of action.
   e. **In analyzing this data, you will be looking for a correlation between full load displacement (the *x* – variable) and the number of hits it takes to put the ship out of action (the *y* – variable).**

   f. The data is divided into three parts. The first part lists ships put out of action by torpedoes, the second part by gunfire, and the third by bombs.

[3] Data comes from LT Thomas R. Beall, USN, "The Development of a Naval Battle Model and Its Validation Using Historical Data," (Monterey, CA, Unpublished Naval Postgraduate School Master's Thesis, 1990), 102 - 104.

SHIP	NATIONALITY	x variable - Displacement (Thousands of Tons)	y variable - Number of Explosive Unit Hits
DAMAGED BY TORPEDOES			
GNEISENAU	Germany	38.90	0.59
LITTORIO	Italy	45.24	0.59
VENETO	Italy	45.03	0.59
ARETHUSA	Great Britain	7.40	0.87
MANCHESTER	Great Britain	11.65	0.87
PHOEBE	Great Britain	6.85	0.87
GLASGOW	Great Britain	11.35	0.87
DENVER	U.S.	14.13	0.87
INDEPENDENCE	U.S.	14.75	0.87
INTREPID	U.S.	34.88	0.87
HOUSTON	U.S.	14.13	0.88
HATSUKAZI	Japan	1.90	0.97
KISUMI	Japan	2.37	0.97
LUTZOW	Germany	16.10	1.10
NURNBERG	Germany	8.40	1.10
SCHARNHORST	Germany	38.90	1.10
CLEOPATRA	Great Britain	6.85	1.20
CAPETOWN	Great Britain	5.18	1.30
COVENTRY	Great Britain	5.24	1.30
FIJI	Great Britain	10.45	1.30
HAMBLETON	Great Britain	2.40	1.30
KEARNEY	U.S.	2.40	1.30
KELLY	Great Britain	2.35	1.30
LIVERPOOL	Great Britain	11.65	1.30
AGANO	Japan	8.53	1.31
KUMANO	Japan	11.00	1.31
TAMA	Japan	5.83	1.31
SELFRIDGE	U.S.	2.60	1.32
MYOKO	Japan	13.67	1.46
CHICAGO	U.S.	11.42	1.60
JUNEAU	U.S.	8.34	1.60
NEW ORLEANS	U.S.	12.46	1.60
PENSECOLA	U.S.	11.51	1.60
PORTLAND	U.S.	12.76	1.60
ST. LOUIS	U.S.	12.21	1.60
KUMANO	Japan	11.00	1.87

SHIP	NATIONALITY	x variable - Displacement (Thousands of Tons)	y variable - Number of Explosive Unit Hits
DAMAGED BY GUNFIRE			
SCHARNHORST	Germany	38.90	0.21
SOUTH DAKOTA	U.S.	44.52	0.26
HIEI	Japan	31.79	0.12
WARSPITE	Great Britain	31.50	0.20
EXETER	Great Britain	10.49	0.08
AOBA	U.S.	10.65	0.11
BOISE	U.S.	12.21	0.05
SAN FRANCISCO	U.S.	12.46	0.24
ONSLOW	Great Britain	2.27	0.03
RALPH TALBOT	U.S.	2.25	0.04
AARON WARD	U.S.	2.40	0.01
ACASTA	Great Britain	1.30	0.01
BROOKE	Great Britain	1.25	0.03
ONSLOW	Great Britain	1.25	0.01
DEFENDER	Great Britain	0.99	0.10
GWIN	Great Britain	2.40	0.02
NORFOLK	U.S.	14.60	0.08
EXETER	Great Britain	11.00	0.04
DAMAGED BY BOMBS			
ITALIA	Italy	45.24	1.11
ILLUSTRIOUS	Great Britain	29.24	0.86
SHOKAKU	Japan	32.11	1.00
ZUIKAKU	Japan	32.11	1.01
SHOKAKU	Japan	32.11	1.01
ZUIHO	Japan	14.20	0.47
KYUHO	Japan	16.70	0.47
AMAGI	Japan	22.80	1.00
MARBLEHEAD	U.S.	7.05	0.23
MOGAMI	Japan	1.32	0.47
MAYA	Japan	15.78	0.47
NAGANAMI	Japan	2.52	0.47
SHAW	U.S.	1.11	0.23
MAYRANT	Great Britain	2.25	0.32
MINEGUMO	Japan	2.37	0.47
MATSUYAKI	Japan	2.39	0.47
ISONAMI	Japan	2.39	0.47
NOWAKI	Japan	2.50	0.47

6. **Getting Started**. To complete this part of the final project, you must do the following:

   a. **First Task:** Enter all of the data into a spreadsheet completely and accurately. **Attach a print – out of this spreadsheet to this paper.**

   b. **Second Task:** Create five graphs of the data, insert **linear trend lines, trend line equations and the R^2 values** for:

      i. *Graph 1:* 'Displacement' vs. 'Number of Explosive Unit Hits' for all ships damaged by torpedoes. **Attach a print – out of this graph to this paper.**

      ii. *Graph 2:* 'Displacement' vs. 'Number of Explosive Unit Hits' for all ships damaged by gunfire. **Attach a print – out of this graph to this paper.**

      iii. *Graph 3:* 'Displacement' vs. 'Number of Explosive Unit Hits' for all ships damaged by bombs. **Attach a print – out of this graph to this paper.**

      iv. *Graph 4:* 'Displacement' vs. 'Number of Explosive Unit Hits' for all ships damaged by bombs and guns. **Attach a print – out of this graph to this paper.**

      v. *Graph 5:* 'Displacement' vs. 'Number of Explosive Unit Hits' for all ships damaged by torpedoes, bombs and guns. **Attach a print – out of this graph to this paper.**

a. **Third Task: Record the results in the table below:**

	Linear Equation	**R^2 Value**
Damaged by Torpedoes		
Damaged by Gunfire		
Damaged by Bombs		
Damaged by Gunfire & Bombs		
Damaged by Torpedoes, Gunfire, and Bombs		

The R^2 value is a measure of how good a linear equation model is – how well it will predict future outcomes. The closer to "1.00" the R^2 value is, the better the linear equation model is. An R^2 value of less than "0.5" is generally an indication that the linear model should not be used.

b. **Fourth Task: Answer this question:** Of the five linear equation models, which should not be used?

_____

_____

_____

_____

_____

c. **Fifth Task:** Complete the final analysis when handed out by the instructor.

Name:_____

Final Analysis

Part I: Have Your Analysis Results Been What You Expected?

In this analysis problem, we have been looking for a correlation between a ship's size (as measured by its displacement) and how many hits it will take to put it out of action. We have been testing the following hypothesis?

The greater the full load displacement of a ship (a measure of how big the ship is) the more shells, bombs, or torpedoes it takes to put her out of action.

Look at the five graphs, their linear equations, and their R^2 values. Does each, in fact show that as size (displacement) increases, more hits are necessary to put it out of action?

1. Ships damaged by torpedoes: Yes / No
2. Ships damaged by gunfire: Yes / No
3. Ships damaged by bombs: Yes / No
4. Ships damaged by bombs and guns: Yes / No
5. Ships damaged from all sources: Yes / No

If your answer was "No" to any of these, explain why ***in a short paragraph*** (3 - 4 sentences) below:

_____

_____

_____

_____

Part II: Which Models Should You Choose?

1. The following illustrations might help you answer the following questions:

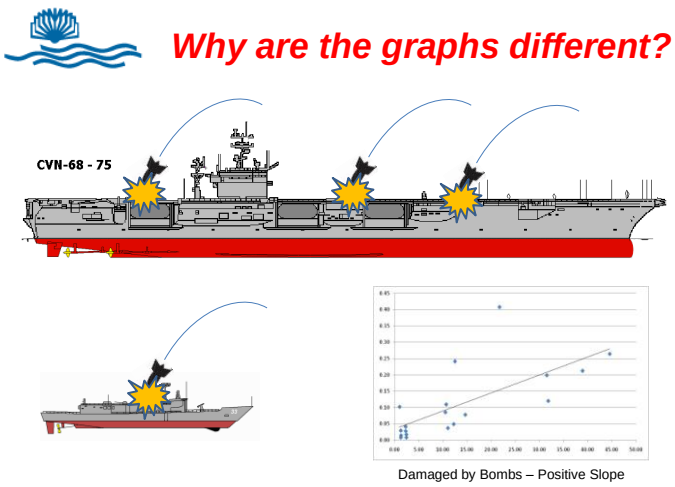


Figure 6: Damaged by Bombs

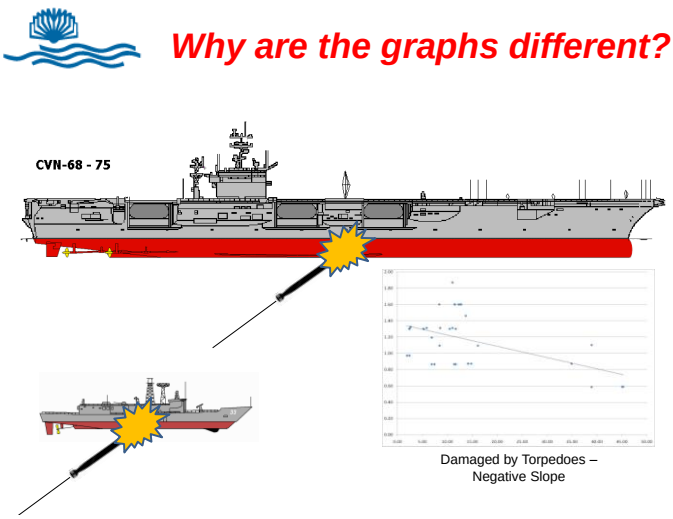


Figure 7: Damaged by Torpedoes

2. The model equation for "Damaged by Torpedoes" shows that as size (displacement) increases, the number of hits necessary to put a ship out of action goes down.

   In a short paragraph (2 – 3 sentences) below, discuss why this model may not be useful to predict how many hits are required to put a ship out of action.

3. The model equation for "Damaged by Torpedoes, Gunfire, and Bombs" shows that as size (displacement) increases, the number of hits necessary to put a ship remains about the same.

   In a short paragraph (2 – 3 sentences) below, discuss why this model may not be useful to predict how many hits are required to put a ship out of action.

4. The model equations for “Damaged by Gunfire”, “Damaged by Bombs”, and “Damaged by Gunfire and Bombs” do show clear relationships between size (displacement) and the number of hits necessary to put a ship out of action.

   In a short paragraph below (at least 3 – 4 sentences), discuss which of the three models, “Damaged by Gunfire”, “Damaged by Bombs”, or “Damaged by Gunfire and Bombs” would be useful to the builder (you may choose more than one). Why would it / they be useful to him?

Task II D – G – Ship Stability
Teacher Notes

Standards: M(G&M)–10–2

Objectives:

1. Understand the importance of stability calculations in the design and construction of a ship.
2. Apply trigonometric functions to determine metacentric height and righting arm of a ship.
3. Graph and interpret stability curves using Microsoft EXCEL.
4. Develop self-confidence and resiliency by completing a challenging and unfamiliar task in which all steps may not be clearly identified.

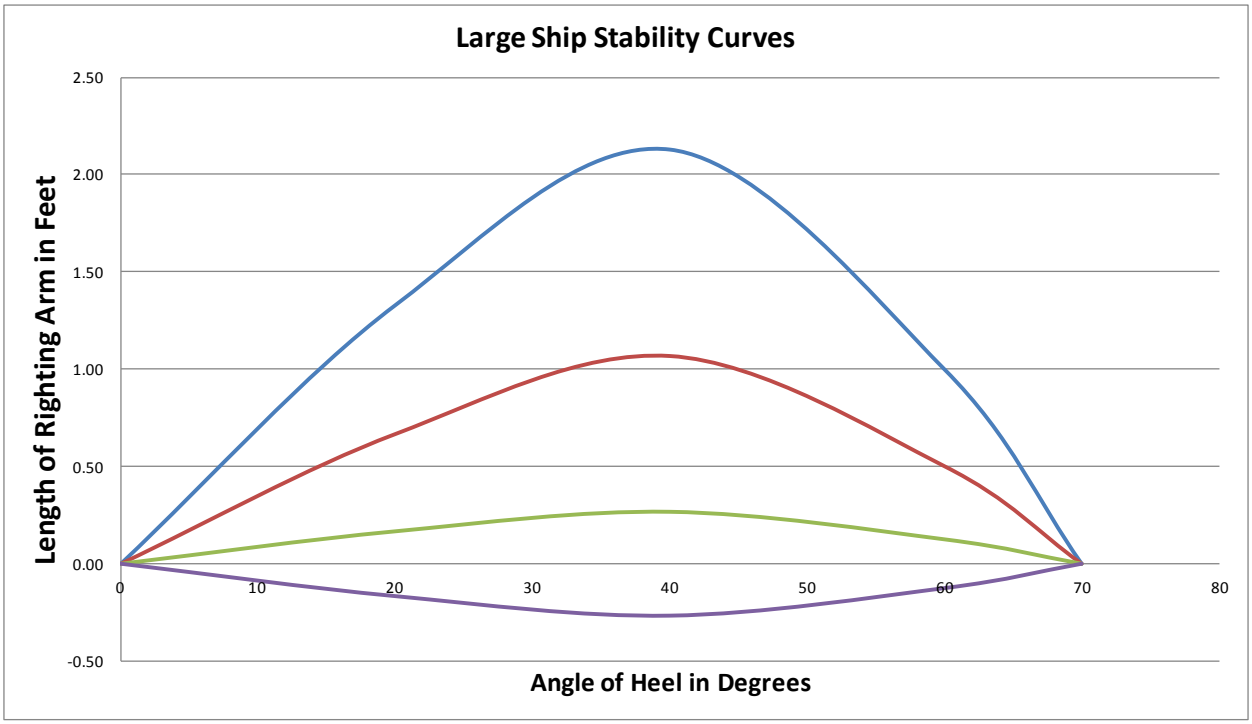
Teacher Support:

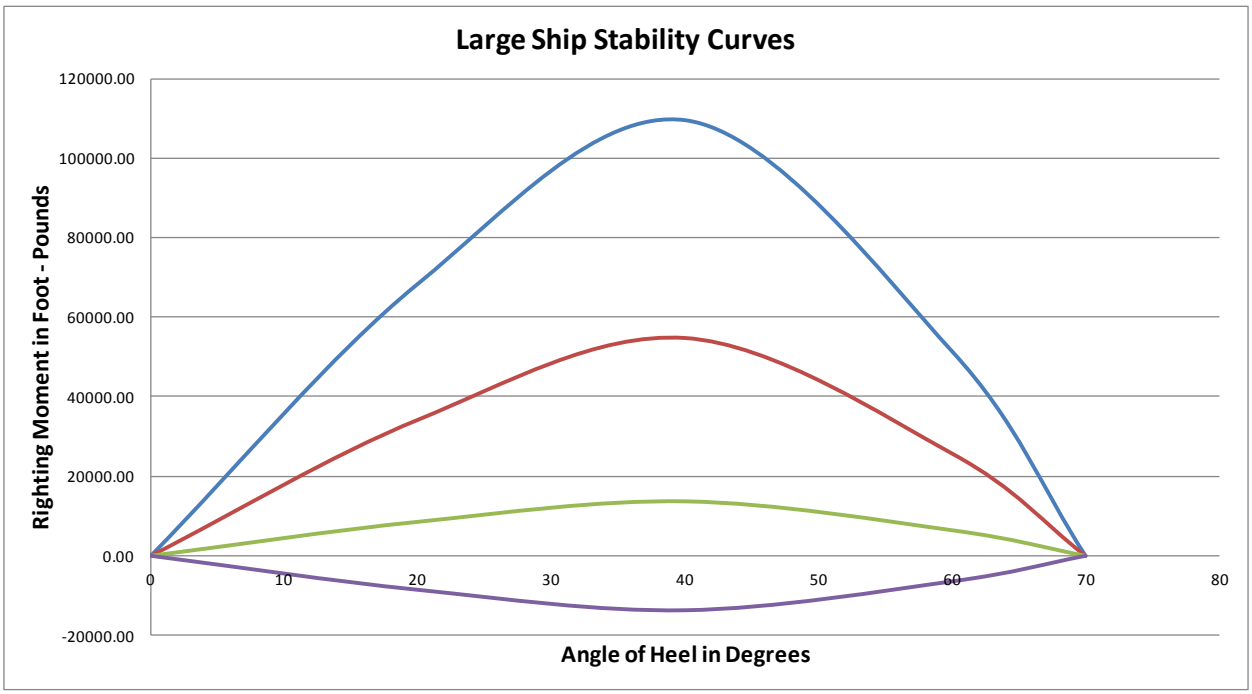
1. The formula asked for in paragraph 7 is: $\frac{GZ}{GM}$.

2. The following is the completed table for task 1:

θ	sin θ	cos θ	GM (in feet)	GZ (in feet)	ZM (in feet)
5°	0.087	0.996	7.18	0.625	7.151
10°	0.174	0.985	7.18	1.249	7.072
15°	0.259	0.966	7.18	1.860	6.936
20°	0.342	0.940	7.18	2.460	6.749
25°	0.423	0.906	7.18	3.037	6.505
30°	0.500	0.866	7.18	3.590	6.218

3. The following are the two graphs which are created from the table of data:





4. The answers to the task 3 questions are:

   a. At what angle of heel is the righting arm longest and the righting moment strongest?

      Approximately 40°.

   b. If the ship heels more than 40° will the ship be more or less likely to capsize (tip over on her side). Why?

      More likely because the righting moment increasingly diminishes as the angle of heel increases beyond 40°. In other words, the force to right the ship diminishes.

   c. The "negative stability" curve is negative, below the x – axis. In this case, what will the "moment" do to the ship?

      Capsize the ship.

Name: _____

Task II D – G – Ship Stability

1. **Standards: M(G&M)–10–2**

2. **Background.** A ship floats because there are two forces acting on its hull in opposite directions.

   a. *Gravity* (G) is the force that is pulling the ship toward the center of the Earth. It is the same force that holds you to the Earth.
   b. *Buoyancy* (B) is the force that is caused by the ship pushing down on the surface of the water because of gravity. The water pushes back.

   G and B are vectors with direction and magnitude. When they act on a ship in opposite directions with equal magnitude (called opposing each other), the ship achieves *equilibrium*, the state in which it is floating on the water, not sinking and not moving up out of the water.

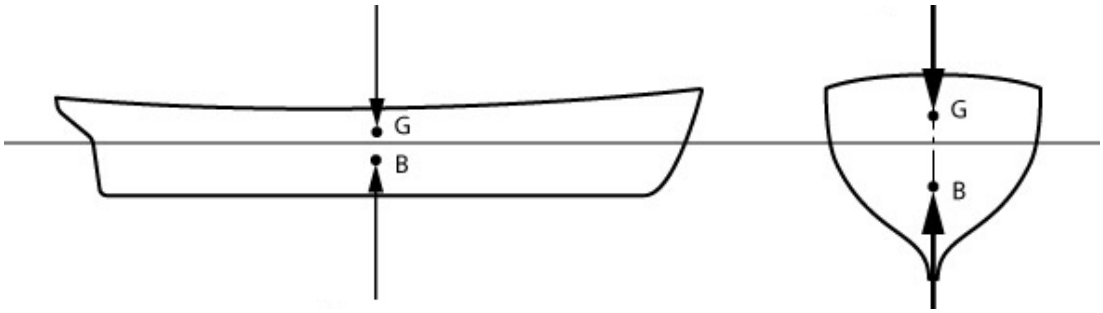


Figure 8: Vectors B and G opposing each other to keep a ship afloat.

3. If a ship did not rock and move with the flow of the sea, figure 8 would be a complete portrayal of how a ship stays afloat. The ship does move however and its these two vectors which bring it back into an upright condition. In figure 9, the ship is tipping (heeling) to the right. B is to the right of G so the two act to shift the ship back into an upright position.

   What do you think would happen if B was to the left of G as the ship heeled to the right?

   _____

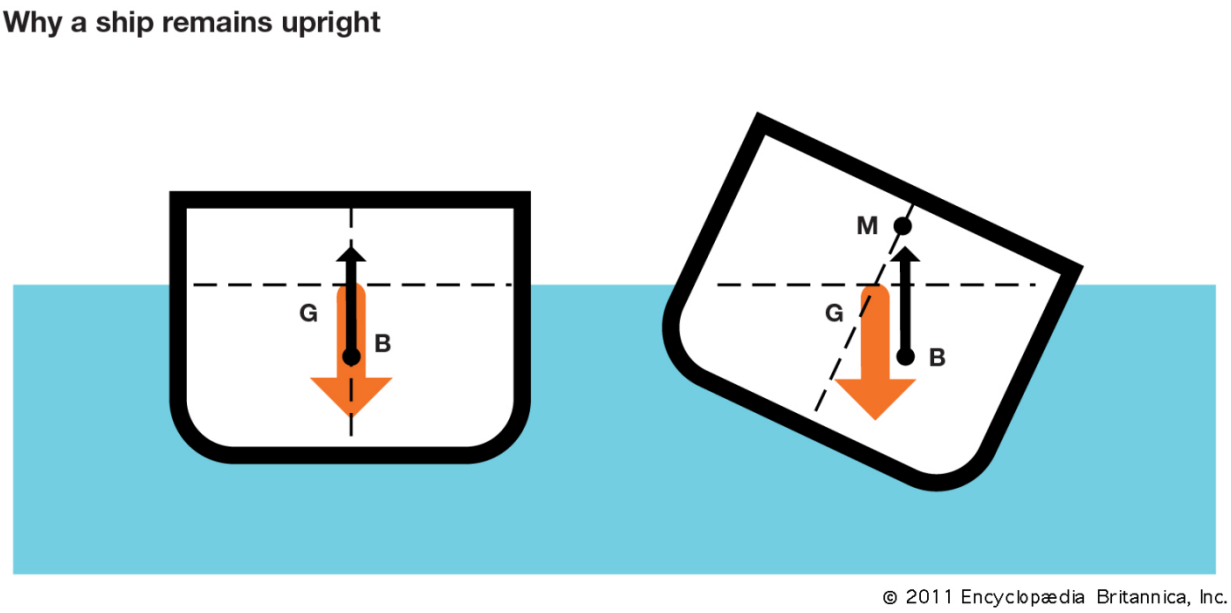


Figure 9: Why a ship remains upright.

4. When a ship heels, the G vector and the B vector do not directly oppose each other. Instead, they form an angle θ as you see in figure 10 below:

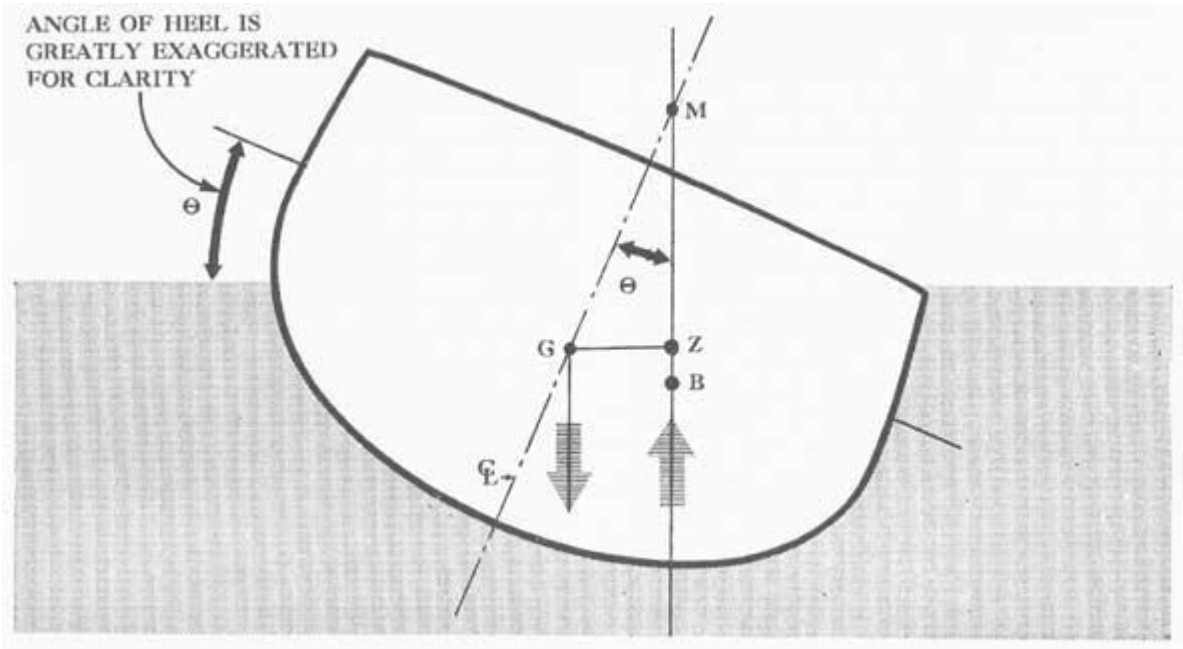


Figure 10: Ship healing to right, angle formed by G and B.

5. The apex of the angle formed by G and B is called the *metacentric height* (M).

Since M is the apex of the G and B vectors, it is a function of those vectors and, therefore, a measure of the ship's overall *stability* – its ability to remain afloat in an upright position.

5. The segment GZ in figure 10 is called the *righting arm*. The longer it is, the more force is exerted to bring the ship back to an upright position.

6. Recall from trigonometry the following relationships:

$$sin\ \theta = \frac{opposite}{hypotenuse}, \quad cos\ \theta = \frac{adjacent}{hypotenuse}$$

7. In triangle ΔGMZ with ∠M = θ, therefore:

   $sin\ \theta =$ _____

8. For angles of heel of 30° or less, we can use the formulas in paragraph 7 to determine the length of the righting arm (GZ) and the metacentric height (GM).

   Task 1: Use the formulas to complete the following table:

θ	sin θ	cos θ	GM (in feet)	GZ (in feet)	ZM (in feet)
5°			7.18	0.625	7.151
10°			7.18		
15°				1.860	6.936
20°				2.460	
25°					6.505
30°				3.590	

9. The table above constitutes the basic stability table for U.S.S. *Massachusetts* (BB 59). Using this and other data gathered from a series of experience, naval architects (ship designers) can develop stability diagrams.

10. **Task 2:** The table below incorporates data from those experiments. Enter this data into Microsoft EXCEL and graph it. You need one graph to include all four "Length of Righting Arm" columns and one to include all four "Righting Moment" columns. A total of two graphs. Attach both to this handout when you turn it in.

Angle of Heel (in degrees)	Length of Righting Arm in Feet	Righting Moment (Normal Stability)	Length of Righting Arm in Feet (Reduced Stability)	Righting Moment (Reduced Stability)	Length of Righting Arm in Feet (Reduced Stability 2)	Righting Moment (Reduced Stability 2)	Length of Righting Arm in Feet (Negative Stability)	Righting Moment (Negative Stability)
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	1.33	68344.71	0.67	34172.36	0.17	8543.09	-0.17	-8543.09
40	2.13	109454.31	1.07	54727.16	0.27	13681.79	-0.27	-13681.79
60	1.00	51387.00	0.50	25693.50	0.13	6423.38	-0.13	-6423.38
70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

11. **Task 3:** Answer the following questions based on the data in the tables and the graphs.

    a. At what angle of heel is the righting arm longest and the righting moment strongest?

    _____

    b. If the ship heels more than 40° will the ship be more or less likely to capsize (tip over on her side). Why?

    _____

    c. The "negative stability" curve is negative, below the x – axis. In this case, what will the "moment" do to the ship?

    _____

Name: _____

9th Grade Final Project: Mathematics and History

Part III: Geometry – Building the Ships

1. **Historical Background.** In the spring of 1942, the United States was on the defensive in the Pacific. The Japanese Empire had conquered vast territories in the Pacific Ocean including the Dutch East Indies (present day Indonesia), the Philippine Islands, Korea, Vietnam, and all of Eastern China (see figure 1). The U. S. Pacific Fleet was still recovering from the Pearl Harbor attack while the U. S. Asiatic Fleet and the British East Indies Fleet had been destroyed in battles with the Japanese.

   While Admiral Chester Nimitz and his Pacific Fleet of three aircraft carrier task forces was holding the American line at the Hawaiian Islands, the U. S. Navy was rapidly building new ships to replace those lost at Pearl Harbor on December 7th, 1941. One of these ships, the *South Dakota* - class battleship U.S.S. *Massachusetts* (BB 59) was completed in May 1942, just in time to join the Fleet to help the Americans begin offensive operations against the Japanese.

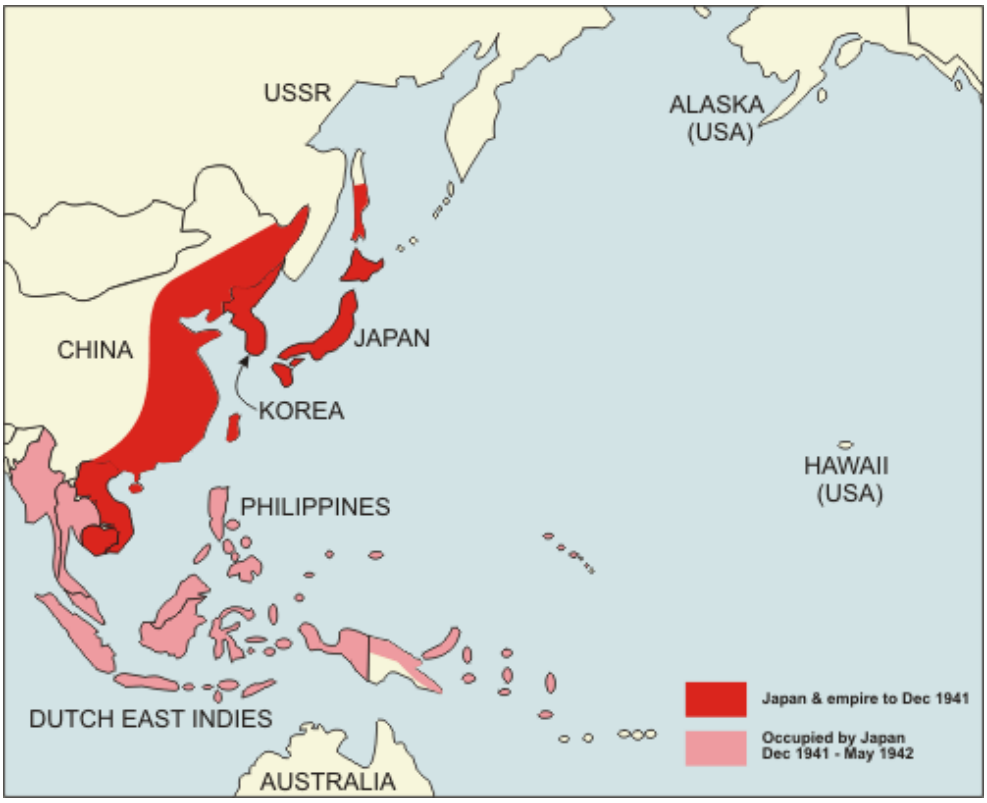


Figure 1: Japanese Empire May 1942

2. **U.S.S. *Massachusetts* (BB 59) Design Specifications.** *Massachusetts* was a battleship, a type of ship originally designed to fight with and against other battleships in great gun battles at sea. By 1942, naval aircraft flown from aircraft carriers and armed with bombs or torpedoes had replaced battleships as the primary offensive weapons at sea. Still, battleships like *Massachusetts* played important roles such as defending the fragile aircraft carriers from enemy attack and using their large caliber guns to bombard enemy positions on shorelines in preparation for attacks from the sea by U.S. Marines and U.S. Army troops.

   Specifications:

Displacement:		43,884 tons
Dimensions:	Length overall:	680 ft., 9.813 in.
	Maximum beam:	108 ft., 2.250 in.
	Maximum draft:	36 ft., 9.000 in.
Armament:		9 16 - inch / 45 caliber (Mark 6) guns
		16 5 - inch / 38 caliber (Mark 12) guns
		Assorted lower caliber guns

3. **Field Trip to Battleship Cove.** In conjunction with this part of the project, and in order to see just what ships of the World War II period looked like, we will take a field trip to Battleship Cove in Fall River, MA. Information can be found at: http://www.battleshipcove.org/.

Photo # 80-G-156818 Drawing of battleships BB 58, 59 & 60 (Indiana, Massachusetts & Alabama), for camouflage planning, circa 1943 -- starboard side

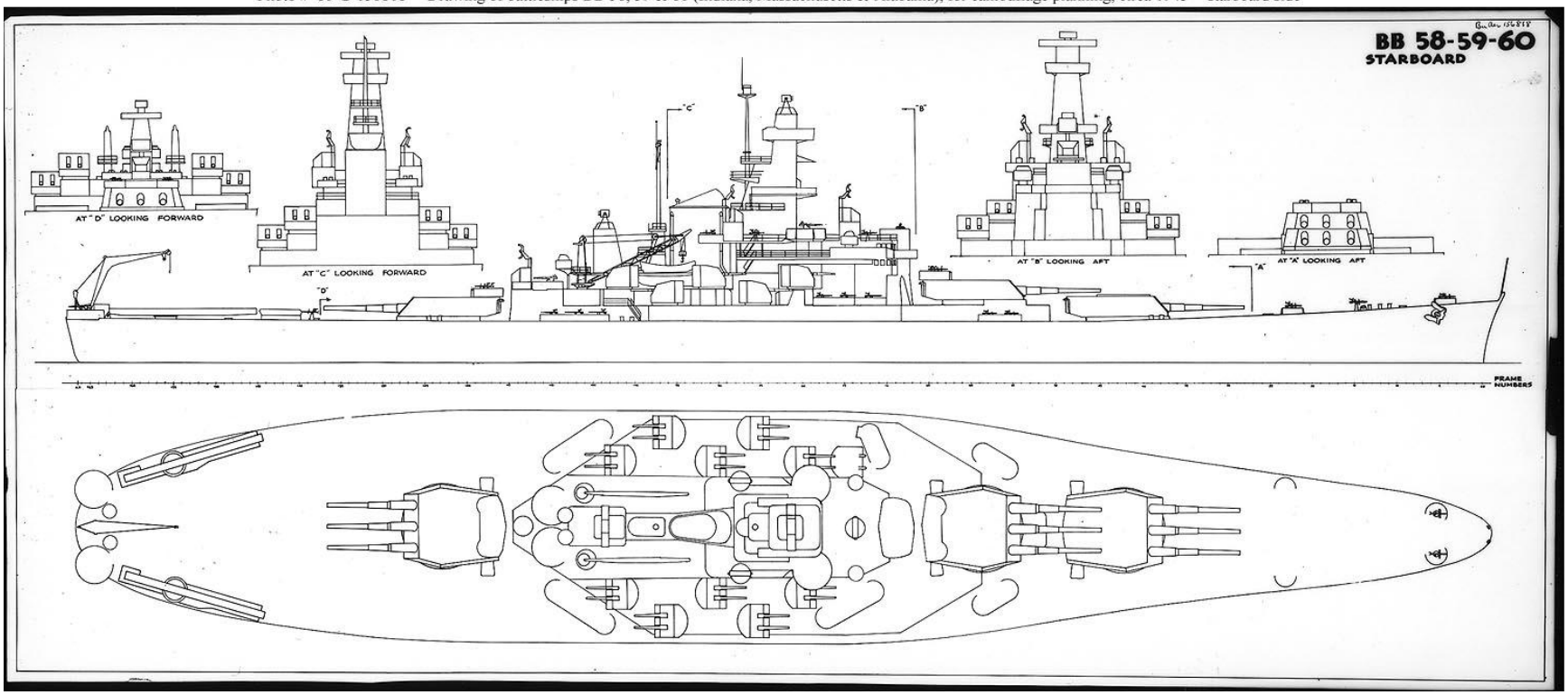


Figure 2: Drawings of a *South Dakota* Class Battleship (Starboard Side)

Photo # 80-G-156819 Drawing of battleships BB 58, 59 & 60 (Indiana, Massachusetts & Alabama), for camouflage planning, circa 1943 -- port side

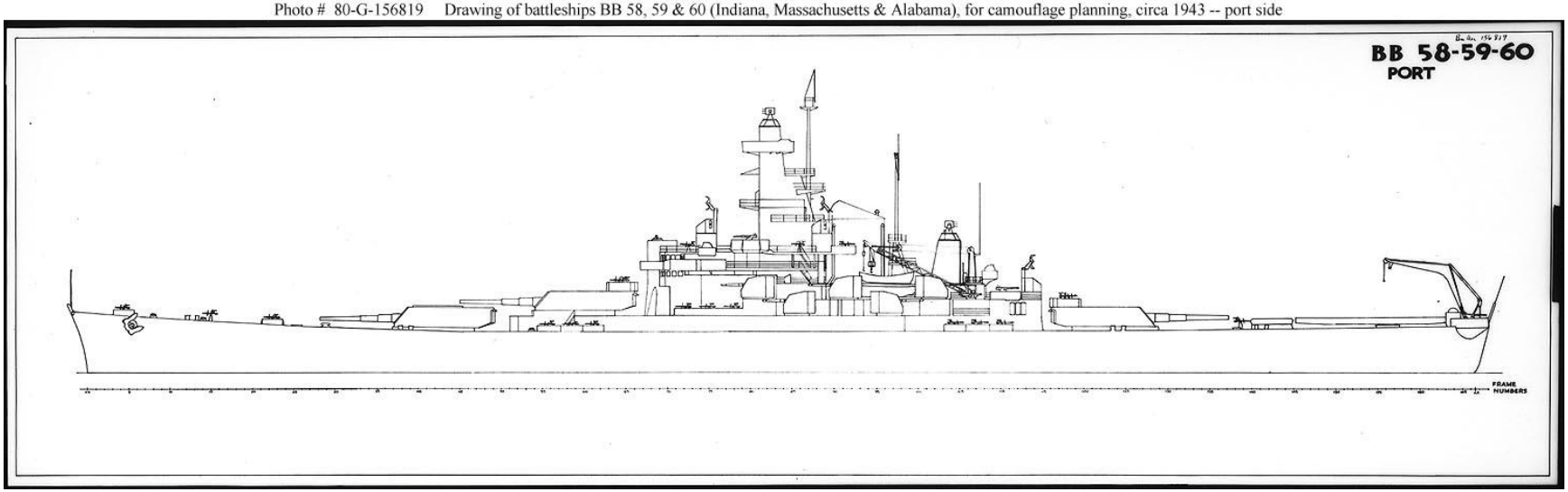


Figure 3: Drawings of a *South Dakota* Class Battleship (Port Side)

Part III: Geometry – Building the Ships
Task III A G/A: Drawing the Ship

Teacher Notes

Standards: M(G&M)–10–5, M(G&M)–10–7, M(G&M)–10–9

Objectives:

1. Identify correct scale factor.
2. Use scale factor to produce a scaled drawing that is similar in dimensions to the actual item being drawn.
3. Develop self-confidence and resiliency by completing a challenging and unfamiliar task in which all steps may not be clearly identified.

Teacher Support:

1. The scale factor is determined by the following equation:

$$\frac{(3\ ft.)}{680.82\ ft.} = 0.0044$$

2. Each measure in feet from figure 4 is multiplied by this scale factor and then multiplied by 12 to convert the actual measure in feet to the scaled measure in inches. For example:

$$105\ ft. \times 0.0044 \times 12\frac{in.}{ft.} = 5.54\ in.$$

3. The final scaled measures needed to prepare the drawing are listed in the following table:

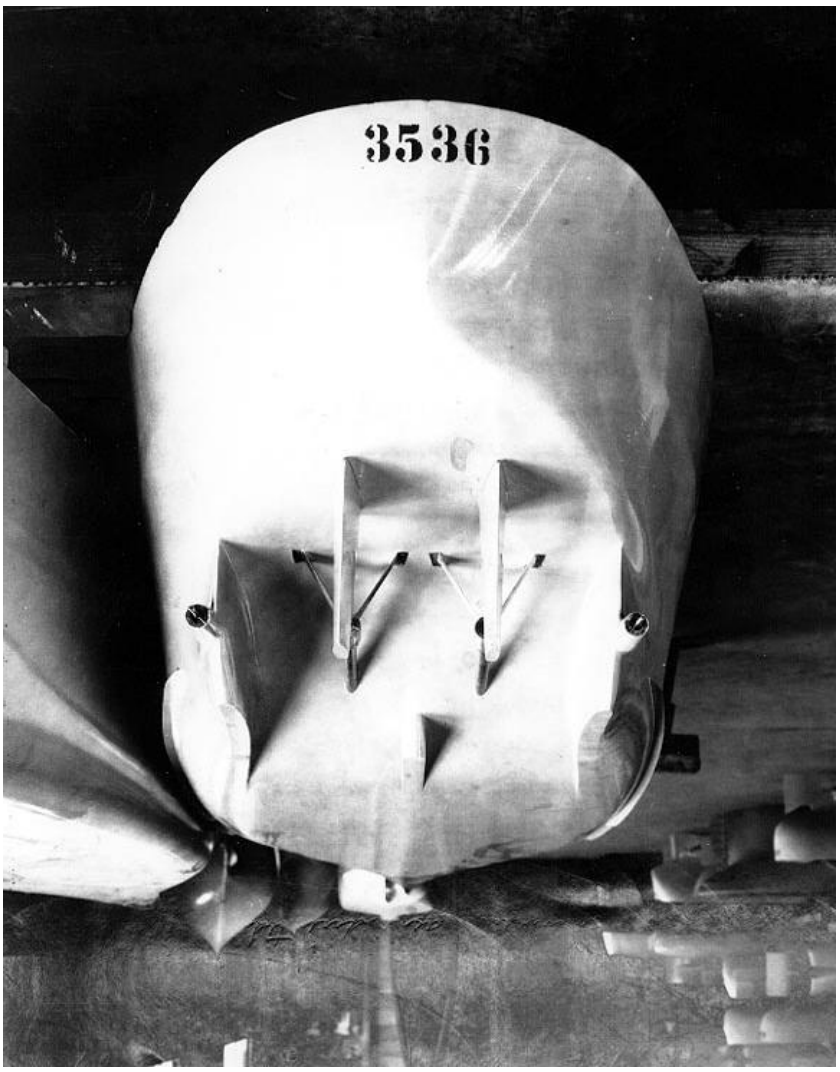
Actual Dimension (feet)	Scale Factor	Drawing Dimension (feet)	Drawing Dimension (inches)
105.00	0.004406451	0.46	5.55
75.00	0.004406451	0.33	3.97
15.00	0.004406451	0.07	0.79
680.82	0.004406451	3.00	36.00
30.00	0.004406451	0.13	1.59
60.00	0.004406451	0.26	3.17
90.00	0.004406451	0.40	4.76
120.00	0.004406451	0.53	6.35
143.00	0.004406451	0.63	7.56

Name: _____

Task III A – G/A
Drawing *Massachusetts*

1. **Standards: M(G&M)–10–5, M(G&M)–10–7, M(G&M)–10–9**

2. **Specifications of Your Model.** A builder's model of a ship is used to help naval constructors visualize what the actual ship should look like and how the ship will operate in the water. This photograph shows a builder's model of U.S.S. *Massachusetts*. You are looking at the stern of the ship where the propellers are mounted.



The actual ship's stern when built is shown in the photograph below. You can see how similar it is to the model.

In preparation for building your model, your first task will be to make a drawing of the ship **that is 36 inches in length**.

2. Answer the following questions about your drawing and your model.

   a. If the actual ship is 680 ft. 9.813 in. in length and your model is 36 inches in length, use this equation to find the number you would multiply the actual length by to get the model length:

$$Actual\ ship\ length\ \times scale\ factor \times \frac{12\ inches}{1\ foot} = Model\ length\ in\ inches$$

   b. The number you just calculated is called the **scale factor**. It is the number by which you will multiply all of the ship's dimensions to get the model's dimensions.

   Scale factor: _____

   Using the scale factor and the dimensions in the drawing above, calculate all of your drawing's dimensions:

Actual Dimension (feet)	Scale Factor	Drawing Dimension (feet)	Drawing Dimension (inches)
105.00			
75.00			
15.00			
680.82			
30.00			
60.00			
90.00			
120.00			
143.00			

Table 1: Drawing Dimensions

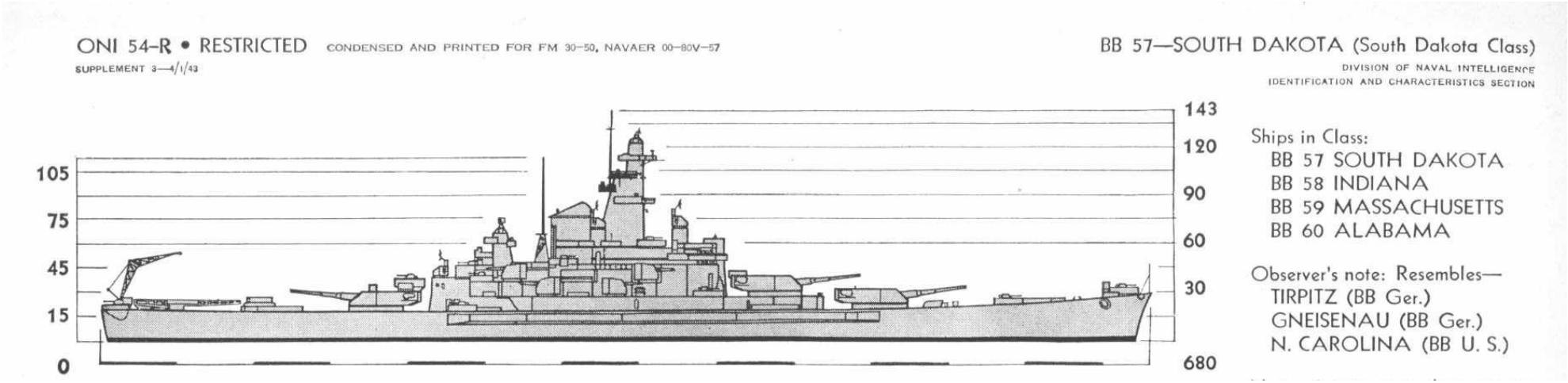


Figure 4: U.S.S. *Massachusetts* (BB-59) drawing

c. **Getting Started.** To begin your drawing:

i. Using graph paper, tape together enough sheets to produce one large sheet that is at least 36 inches long and 9 inches tall.

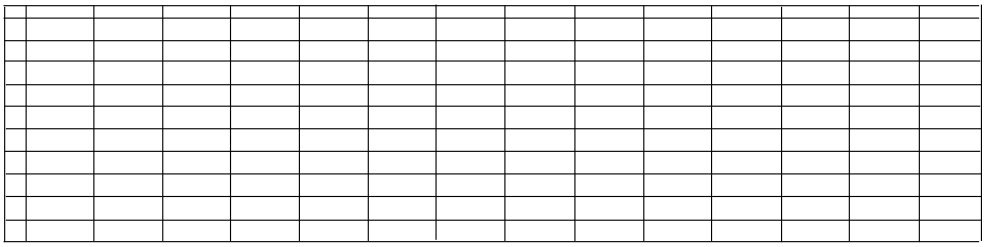
ii. Near the bottom of the large sheet, centered, draw a line 36 inches in length.

iii. Along this line, measure off segments that correspond to 100 feet in the drawing in figure 4 (multiply 100 by the scale factor and then by 12 inches to one foot). The last segment will be shorter.

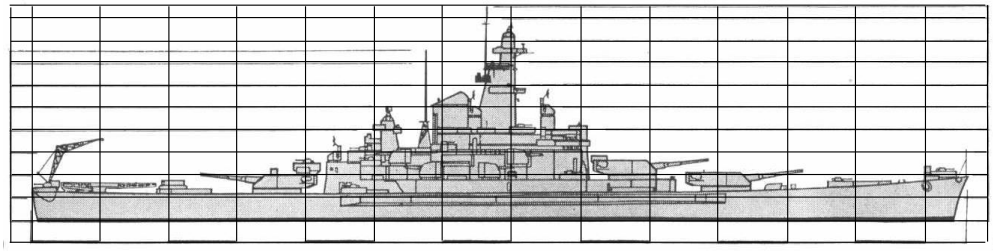
iv. At the left end of the 36 inch line, measure off segments that correspond to the measured segments on the left side of figure 4, using the "Drawing Dimension (inches)" numbers in Table 1.

v. Repeat using the measured segments on the right side of figure 4.

vi. You now have a reference grid in which to recreate the drawing in figure 4. The grid might look something like figure 5 below, before and after the drawing is completed:



Before Drawing



After Drawing

Figure 5: Reference Grid

Task III B – A
Constructing the Model

Teacher Notes

Standards: M(G&M)–10–4, M(G&M)–10–10

Objectives:

1. Reflect a detailed drawing accurately across an axis.
2. Create a three-dimensional shape from a two-dimensional drawing.
3. Develop self-confidence and resiliency by completing a challenging and unfamiliar task in which all steps may not be clearly identified.

Teacher Support: Students typically have the following problems with this task:

1. Achieving accuracy when reflecting the drawing. Many students try to draw it freehand. A better approach is to use a ruler and measure the distance of specific points on the completed half to the axis. These points can then be reflected precisely across the axis using those measurements. Once the points are reflected, it becomes a simple matter of connecting the dots to produce a fairly precise reflection.

2. Cutting the drawings to trace the frames. Many students try to cut all the edges first. Students should "cut and trace, cut and trace."

3. Creating the center portion. Once students have reflected the forward portion of the ship, the instructions clearly state that they are to cut out the entire drawing and trace it nine times. These form the center portion of the ship. *They do not need to trace the after portion nine times.*

4. Spacing the frames. The entire model is 36 inches long. Each frame should be evenly spaced using precise measurements. Students often overlook this step.

Name: _____

Task III B – A
Constructing the Model

This task is due at the beginning of class on Friday, April 19th, 2013

Part 1: Preparing the Template

Standards: M(G&M)–10–4, M(G&M)–10–10

Directions: Each drawing is one half of the body plan of a naval architect's ship drawing. The first drawing depicts ½ of the ship as you would see it if you were standing directly in front of the ship looking at the bow. The second drawing depicts ½ of the ship as you would see it if you were standing directly behind the ship looking at the stern.

Your task today is to produce a precise mirror image of each drawing, connected to the first drawing so that you have a complete view of the plan of the forward part of the ship and the aft part of the ship.

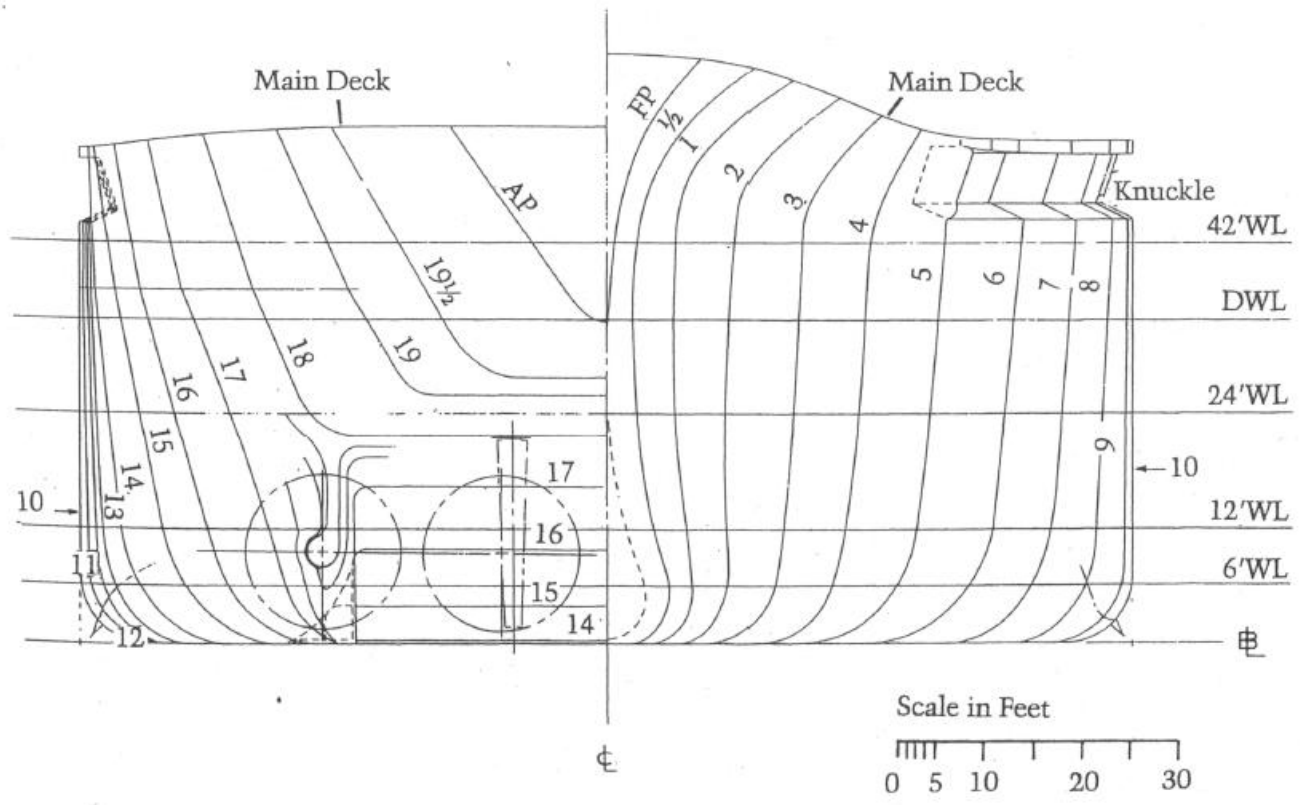


Figure 1: Complete Body Plan

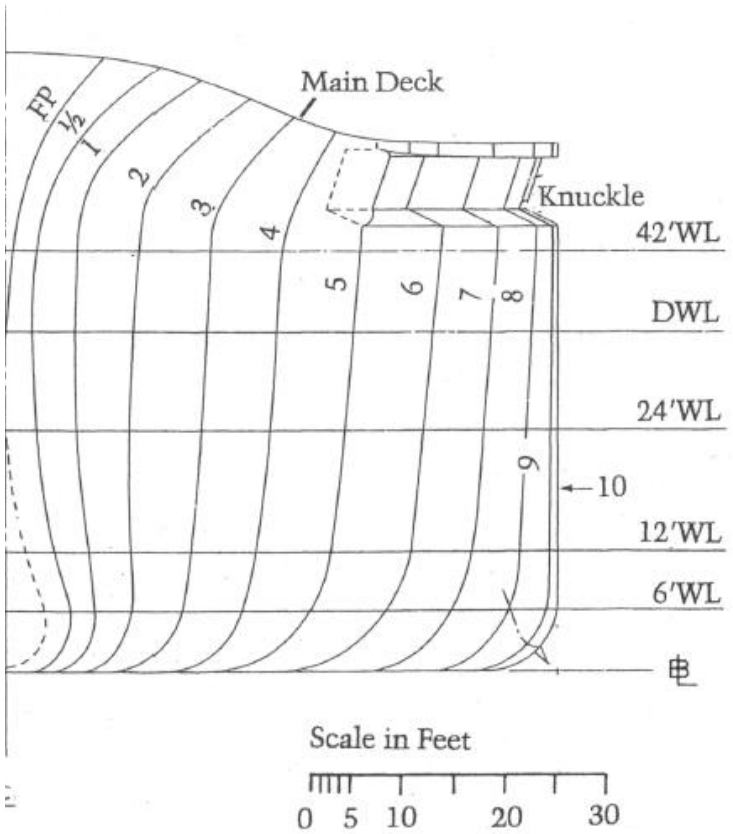


Figure 2: Body Plan – Forward Part of the Ship

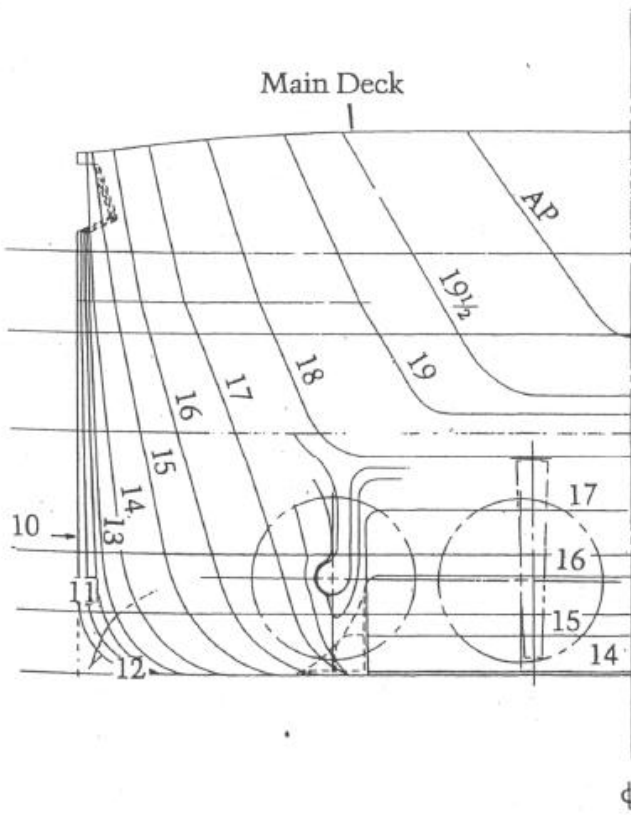


Figure 3: Body Plan – After Portion of the Ship

Name: _____

Part 2: Constructing the Model

Getting Started: You will construct a builder's model ship from your drawings. When your drawings from Task III B Part 1 are approved by the instructor, follow these instructions very carefully.

1. For the drawing of the forward part of the ship:

   a. Cut out the entire drawing.

   b. Trace the outline on poster-board. Trace this outline (**and only this outline**) 9 times.

   c. Cut the outermost counter line on each side from the drawing and trace the remaining portion of the drawing onto poster-board.

   d. Repeat step 1.c, cutting the remaining outermost counter line on each side from the drawing and tracing the remainder. Repeat this until you have reached and traced the center-most contour lines.

   e. Cut out all traced outlines from the poster-board and set them aside.

2. For the drawing of the after part of the ship:

   a. Cut out the entire drawing.

   b. Trace the outline on poster-board. Trace this outline **only once**.

   c. Cut the outermost counter line on each side from the drawing and trace the remaining portion of the drawing onto poster-board.

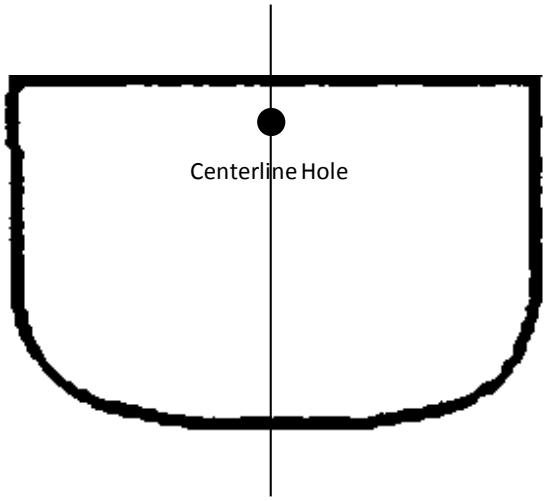
d. Repeat step 2.c, cutting the remaining outermost counter line on each side from the drawing and tracing the remainder. Repeat this until you have reached and traced the center-most contour lines.

e. Cut out all traced outlines from the poster-board and set them aside.

3. Take 4 of the kabob skewers, place them end to end (**do not glue them together yet**). With a ruler, measure 34 equidistant notches (one for each of your cut pieces).

4. Place all of the pieces of the forward part of the model (including the 9 identical pieces) on top of each other just as in the original picture.

   a. With a hammer and nail, drill a hole through all of the pieces.



   b. With a glue gun, glue each piece to a notch on one of your skewers. The pieces should be placed in order from smallest to largest with the identical pieces last.

5. Place all of the pieces of the after part of the model on top of each other just as in the original picture you drew.

   a. With a hammer and nail, drill a hole through all of the pieces.

b. With a glue gun, glue each piece to a notch on one of your skewers. The pieces should be placed in order from smallest to largest.

6. Glue the kabob skewers together such that they form the outline of the ship: forward part from smallest to largest, middle part with the 9 identical pieces, after part from largest to smallest.

7. Carefully trace the top of the model onto construction paper. Cut the trace out and glue it to the top of the model as a top deck.

8. To receive a grade of "4", cover the entire hull such that your model will float. To receive a grade of "5", build a superstructure onto your ship such that she resembles the actual ship as closely as possible.

Name: _____

U.S.S. *Massachusetts* Layout and Design

1. **Ship Compartmentation.** Every room on a naval ship is called a compartment and is assigned an identifying letter - number symbol. This symbol is marked on a label that is found somewhere in the compartment.

   a. An example would be:

   C - 217 - A

   b. The first letter indicates the section of the ship the compartment is in. There are three sections:

      A - all compartments forward or ahead of the engine rooms.

      B - the engine rooms

      C. - all compartments aft or behind the engine rooms.

      In the example above, the compartment is in the C section and is, therefore, aft of the engine rooms.

2. The number has three digits:

   a. The first number indicates the deck. "1" is the main deck. Decks above "1" have a "0" in front of them.

   b. In the example above, the compartment is on the second deck.

3. The next two numbers indicate the side of the ship the compartment is on. Odd numbers, like "17" above, are on the starboard side; even numbers are on the port side.

a. The final letter indicates the use of the compartment.

i. A is supply and storage
ii. C is control
iii. E is machinery
iv. F is fuel
v. L is living quarters
vi. M is ammunition
vii. T is trunks and passages
viii. V is voids
ix. W is water

In the example above the compartment is a supply and storage compartment.

Compartment	Section	Deck	Side	Use
C - 217 - A	C	2	Starboard	Supply
C - 201- L				
B - 204 - 1E				
A - 213 - L				
B - 0224 - L				
A - 0116 - C				
A - 0225 - E				
B - 0402 - C				
B - 326 - E				
A - 402 - F				
A - 425 - V				
C - 445 - W				
B - 501 - F				
B - 234 - V				
A - 601 - V				
A - 503 - M				
C - 0216 - C				
A - 0143 - E				
B - 409 - M				

Name: _____

U.S.S. *Massachusetts* (BB 59) Field Trip Reflection

1. **Background.** 1800 men lived and worked aboard U.S.S. *Massachusetts* when she was in service in the Navy. They slept there, ate there, worked there, and relaxed there. As you walk around the ship, try to imagine what it would be like to do that for many months without the opportunity to go home, visit your family or friends, or even leave the ship.

2. **Tasks.**

   a. Find a compartment in *Massachusetts* (a room on a ship) where enlisted sailors (not officers) slept. Answer the following questions:

      i. What is the compartment number of this compartment? _____

      ii. Estimate the number of square feet of this compartment _____ (Hint: think of the floor as a giant rectangle and find its area)

      iii. How many men could sleep in this compartment? _____

      iv. What would be difficult about sleeping in a place like this?

      _____

      _____

      _____

      _____

v. Think about a time when you have come to a place where everyone knew each other but no one knew you.

If you were a new sailor moving into this sleeping compartment and everyone else was a stranger, what kinds of things would you need to do to get along with your new shipmates with whom you will live for one year?

vi. Aboard *Massachusetts* there is no place for electronics such as phones or electronic games.

Imagine that you have to move aboard and live aboard for one year without going ashore and with no possibility that anyone can bring you anything.

You can only bring aboard one suitcase for all of your clothes and your personal items.

In addition to your clothes, what would you bring with you in the suitcase to last you for a year?

_____

_____

_____

_____

vii. Aboard the submarine, you can bring a suitcase, one half the size of the one you can bring aboard *Massachusetts*. What would you bring to live in the submarine for one year?

_____

_____

_____

viii. You notice that there are no televisions aboard *Massachusetts* (they had only just been invented when the ship was built).

There is no place to watch TV or movies or to listen to recorded music.

How will you keep yourself entertained during your off hours for the year that you are onboard?

_____

_____

_____

_____

ix. You notice there are no vending machines nor is there a Walgreens outlet. The tiny ship's store only sells very limited items.

What will be the hardest thing to give up for the year you have to live in the ship?

_____

_____

_____

Name: _____

9th Grade Final Project: Mathematics and History

Part IV: War Game: Re – Fighting the Battle of Midway

1. **Historical Background.** While it was the Prussian Germans who developed the first modern war game, *Kriegspiel* in 1824, the modern naval war game was born in the State of Rhode Island when Lieutenant William McCarty Little, U.S.N., introduced a naval version of *Kriegspiel* at the Naval War College in Newport in 1886. The purpose of the war game was to simulate naval battle with enough realism that naval officers could practice the command decision – making they would use in an actual battle.

   In the days prior to electronic simulation, war games were played on gigantic game boards like the one seen below in Pringle Hall at the Naval War College. Each checkerboard square on the game floor represented some number of square miles. The men on their hands and knees used scaled measuring devices to measure direction and range of movement of various ships being employed in the game. The players sat around the play area, taking turns like in any board game. Umpires, such as the man in the grey suit standing with his hands behind his back, evaluated the outcome of each game move, awarding points and judging which player was the winner of the move.

   War gaming before electronics was a very complicated process involving much planning and detailed execution to ensure the game seemed real to the players. A successfully planned and executed war game would give the players insights into how to fight a real war. The Naval War College was very skilled at planning and executing such games, preparing generations of senior naval officers to fight real battles. Fleet Admiral Chester Nimitz, the U.S. naval commander in the Pacific Theater in World War II, said of his experience war gaming at the college, "The enemy of our games was always Japan, and the courses were so thorough that after the start of World War II, nothing that happened in the Pacific was strange or unexpected."[4] The war game planners of the Naval War College could be justly proud of their efforts helping prepare the

[4] http://www.pbs.org/wgbh/amex/macarthur/peopleevents/pandeAMEX90.html.

American naval commanders for their role in bringing about the great victory at the Battle of Midway.

Figure 6: A naval war game at Pringle Hall, U. S. Naval War College, Newport, RI.

We will refight the Battle of Midway by playing a war game that uses many of the techniques that Naval War College students such as Fleet Admiral Nimitz used in the 1920's and 1930's – the years before World War II. The outcome of our game may be different from that of the actual battle. It will be decided by the player(s) who most skillfully employ their naval forces in the simulated battle.

War Game Preparation and Training

Name:_____

Task IV A – G / A: Designing the Game Board

A. **Standards: M(G&M)–10–5, M(G&M)–10–7**

B. **Location and Layout.** The game board is located in the center of the 9th grade mathematics classroom (Room 327), inside the circle around which the desks are normally arranged. It will consist of a scaled map of the Hawaiian Islands, Midway Island and an area of the Central Pacific Ocean out to 600 nautical miles west of Midway Island.

1. North will be toward the north wall of the classroom (where the projector screen is).

2. The Hawaiian Islands will be depicted in the southeast corner of the map and will include the islands of Hawai'i, O'ahu, Maui, Kaua'i, Moloka'i, and Lana'i. The map drawings of the islands will be scaled to the map.

3. Midway Island will be depicted on the map northwest of the main Hawaiian Islands, also scaled to the map. The actual distance from Pearl Harbor on the island of O'ahu to Midway is 1300 nautical miles.

4. The map will be scaled to include the six main Hawaiian Islands, Midway Island and an area of a circle around Midway with a radius of 600 nautical miles.

5. The map's grid is already cut into the game board table. These will be subdivided as necessary to facilitate movement of game pieces across the map.

C. **Task 1: Creating the Map.** You will determine the scale of the game board and then produce scaled drawings of the Hawaiian Islands and Midway Island.

1. **Step 1:** Measure with a yardstick the distance from the southeast corner of the map to the northwest corner in inches. This is the map total distance in inches.

2. **Step 2:** The actual distance from the southeast corner of the mapped area to the northwest corner will be $1300\ nm + 600\ nm = 1900\ nm$. Convert 1900 nm to inches ($1\ nm = 2000\ yards, 1\ yard = 36\ inches$). This is the actual total distance in inches.

3. **Step 3:** Determine the scale factor (SF) of the map using the map total distance in inches (M) and the actual total distance in inches (A). Write and solve the equation for the scale factor (SF).

4. **Step 4:** Complete the following table, converting actual measures to scaled measures or scaled measures to actual measures. For the Hawaiian Islands and Midway, use the maps below to estimate the actual east – west and north – south distances of each island. For the tile, find the length in inches, this is the scaled measure. We want to find the actual measure.

	Inches		x Scale Factor (SF)	in Inches		x Scale Factor (SF)	in Inches	
Distance from Pearl Harbor to Midway + 600 nm								
Length of a Tile								
	East - West	North - South		East - West	North - South		East - West	North - South
Island of Hawai'i								
Island of O'ahu								
Island of Maui								
Island of Kaua'i								
Island of Moloka'i								
Island of Lana'i								
Midway Island								

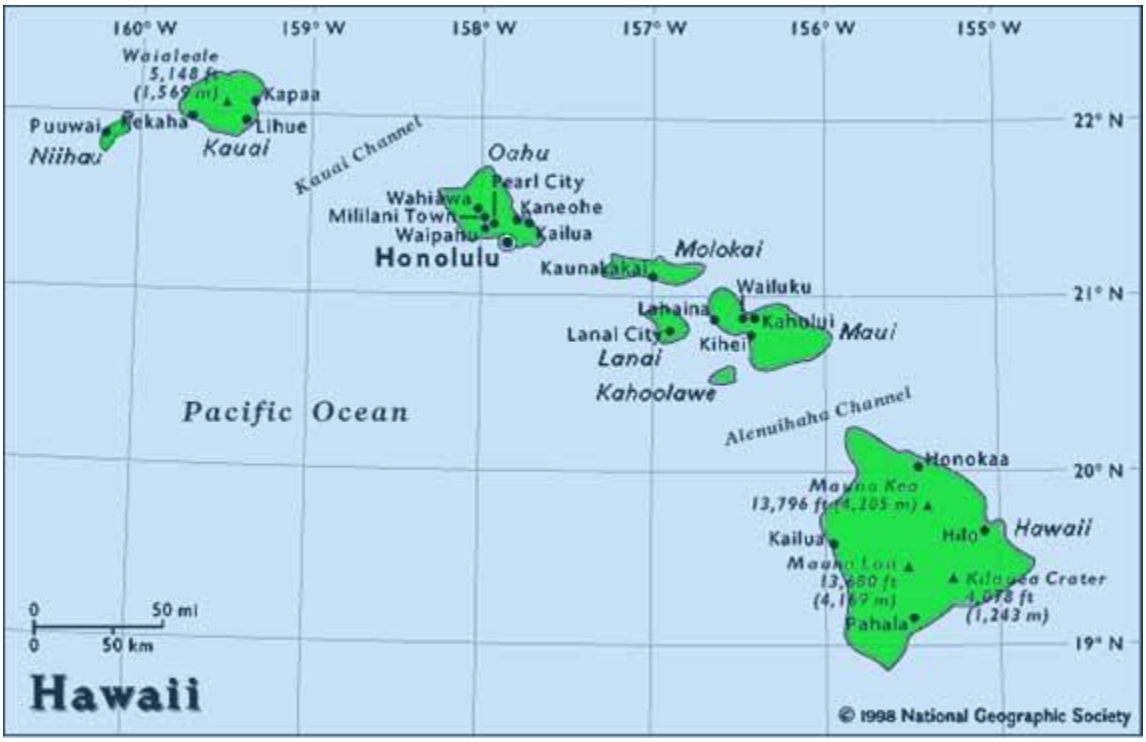


Figure 7: Hawaiian Islands

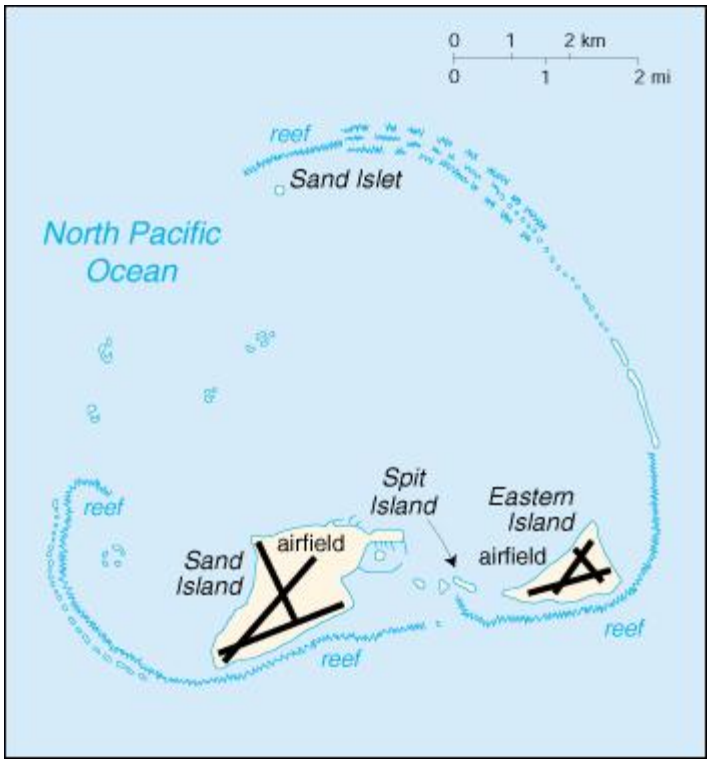


Figure 8: Midway Island

5. **Step 5:** Using the scaled measures from the table, sketch the Hawaiian Islands and Midway Island to the scale of the map. Attach the drawings to these sheets. The best sketch will be used to draw the game board map. The artist will receive a "5" on this portion of the project.

C. **Task 2.** The fleet tankers U.S.S. *Platte* and U.S.S. *Cimarron* have been ordered to sea to support the Midway Operation. They are to operate in the following area defined by latitudes and longitudes that are the solutions to these systems of equations.

1. Solve each system of equations using any two of the methods we have learned ***except the Microsoft EXCEL program*** to determine the latitude and longitude of each point (**show all work on separate sheets of paper**).

		x_i and y_i are solutions to the following systems of equations
Point A	x_1° N, y_1° W. x_1 = _____, y_1 = _____	$8x + y = 415$ $6x + y = 353$
Point B	x_2° N, y_2° W. x_2 = _____, y_2 = _____	$4x + -y = -55$ $2x + -y = -111$
Point C	x_3° N, y_3° W. x_3 = _____, y_3 = _____	$1x + 7y = 1167$ $-1x + 14y = 2256$
Point C	x_4° N, y_4° W. x_4 = _____, y_4 = _____	$-4x + 5y = 699$ $3x + 8y = 1391$

2. Determine the bearing and range of each point from Pearl Harbor, Hawaii. Then calculate the time in days, hours, and minutes it will take a ship traveling at 15 knots and 20 knots to reach each point from Pearl Harbor.

	Bearing	Range	Time at 15 kts.	Time at 20 kts.
Point A				
Point B				
Point C				
Point C				

Task IV B – G: Maneuvering Board Exercise

1. **Standards: M(G&M)–10–6**

2. Ships of a carrier task force normally sailed together in a formation on a base course and base speed (the course and speed of the aircraft carrier). The aircraft carrier was normally in the center of the formation while cruisers and destroyers took positions around the aircraft carrier to protect it from attack by aircraft, other ships, or submarines.

   a. Battleships and cruisers normally took a point station around the aircraft carrier – each maintaining a fixed relative bearing and range from the carrier. For example, the cruiser U.S.S. *Astoria* (CA 34) might have been assigned a position 270° relative at 2000 yards from the aircraft carrier U.S.S. *Yorktown* (CV 5). She would therefore take a position on *Yorktown's* port (left) side at 2000 yards.

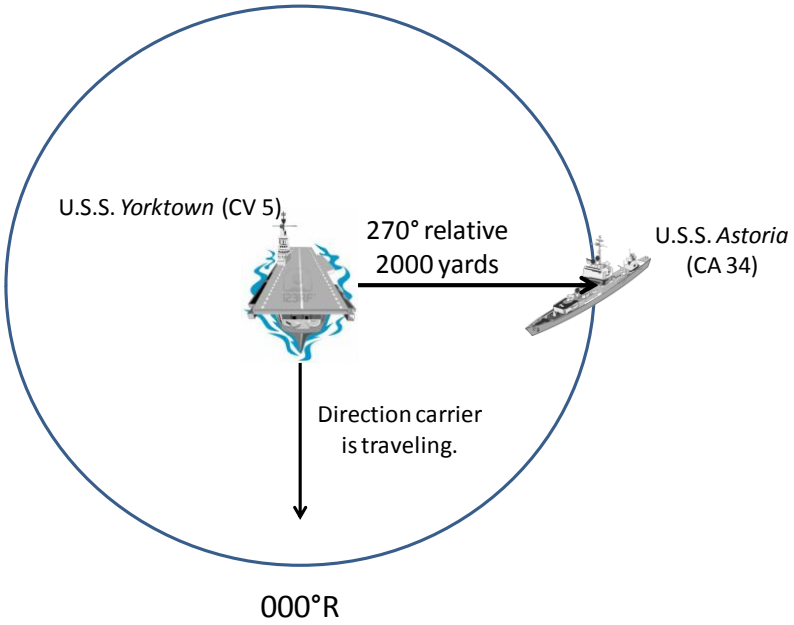


Figure 4: *Astoria* 270° relative, 2000 yards from *Yorktown*.

   b. Destroyers normally took a patrol sector between two bearings and two ranges from the aircraft carrier. This allowed them to patrol actively for enemy submarines that might try to sink the carrier. For example, U.S.S. *Hammann* (DD 412) might be assigned a sector

between 000° and 030° relative, 4000 yards to 6000 yards from *Yorktown.*

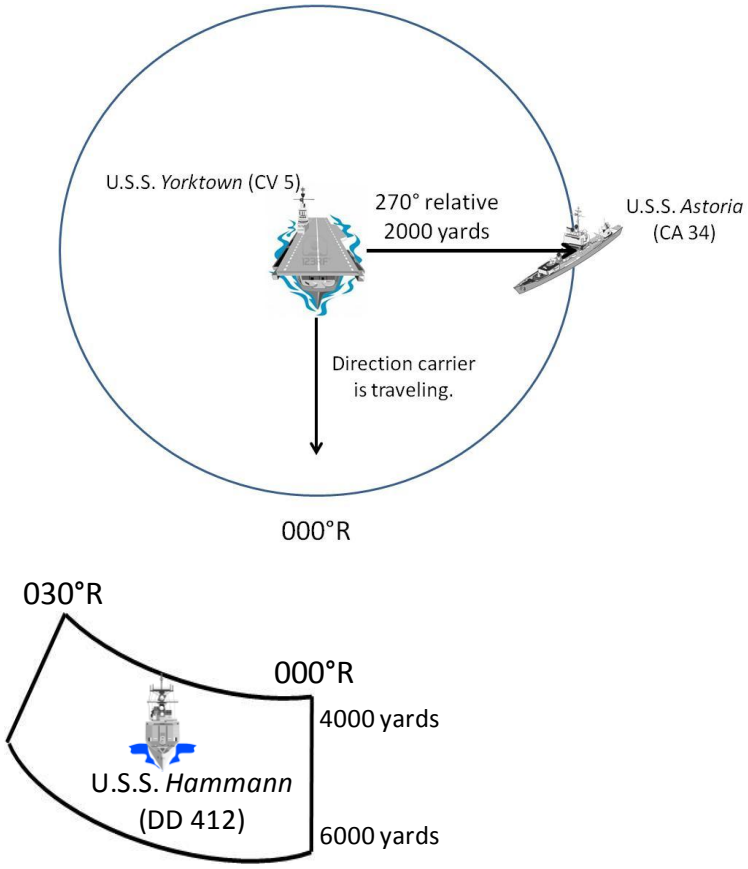


Figure 5:
Hammann* in sector station 000°R - 030°R, 4000 – 6000 yards from *Yorktown.

3. **Task.** You will decode the following message. It is encoded twice. Once you solve the encrypted number code, you will use EXTAC 1000 to break the code a second time.

   a. Break the code and attach the solution to this sheet.
   b. Plot the location of TF 17's ships (the *Yorktown* task group) on a maneuvering board sheet, and answer the questions below. Refer to the CINCPACFLT Operations Order (Appendix 3) for the names of TF 17 ships.

c. Answer the questions on the last sheet.

Getting Started.

1. The unencrypted message contains both letters and numbers.
2. As a first step, the letters were converted to their number equivalents, the numbers were left alone.
3. As a second step, an arithmetic operation was performed on all numbers. The operation was either multiplicative or power.
4. In the unencrypted message, the letter "a" appears most often, the number "0" appears most often.

361	9	324	25	25	196		121	81	144	225		676	676		625	225	324	121	400	225	529	196
0	49	1	1		0	16	0	36		1	361	400	225	324	81	1						
4	25	4	81		0	16	0	36		256	225	324	400	144	1	196	16					
4	64	9	4		0	36	1	0		169	225	324	324	81	361							
4	16	4	64		0	36	1	0		64	441	49	64	25	361							
4	0	4	16		0	36	1	0		1	196	16	25	324	361	225	196					
9	4	0	0		0	36	1	0		64	1	169	169	1	196	196						
0	0	0	16		0	36	1	0		324	441	361	361	25	144	144						
4		9	225	324	256	25	196		9	0	0											
4		361	256	25	25	16		4	25													

5. What is the area in square yards of:

Astoria's sector: _____

Portland's sector: _____

Hammann's sector: _____

Hughes' sector: _____

Morris' sector: _____

Anderson's sector: _____

Russell's sector: _____

Name: _____

Task IV B – G / A: Developing Communications Signals

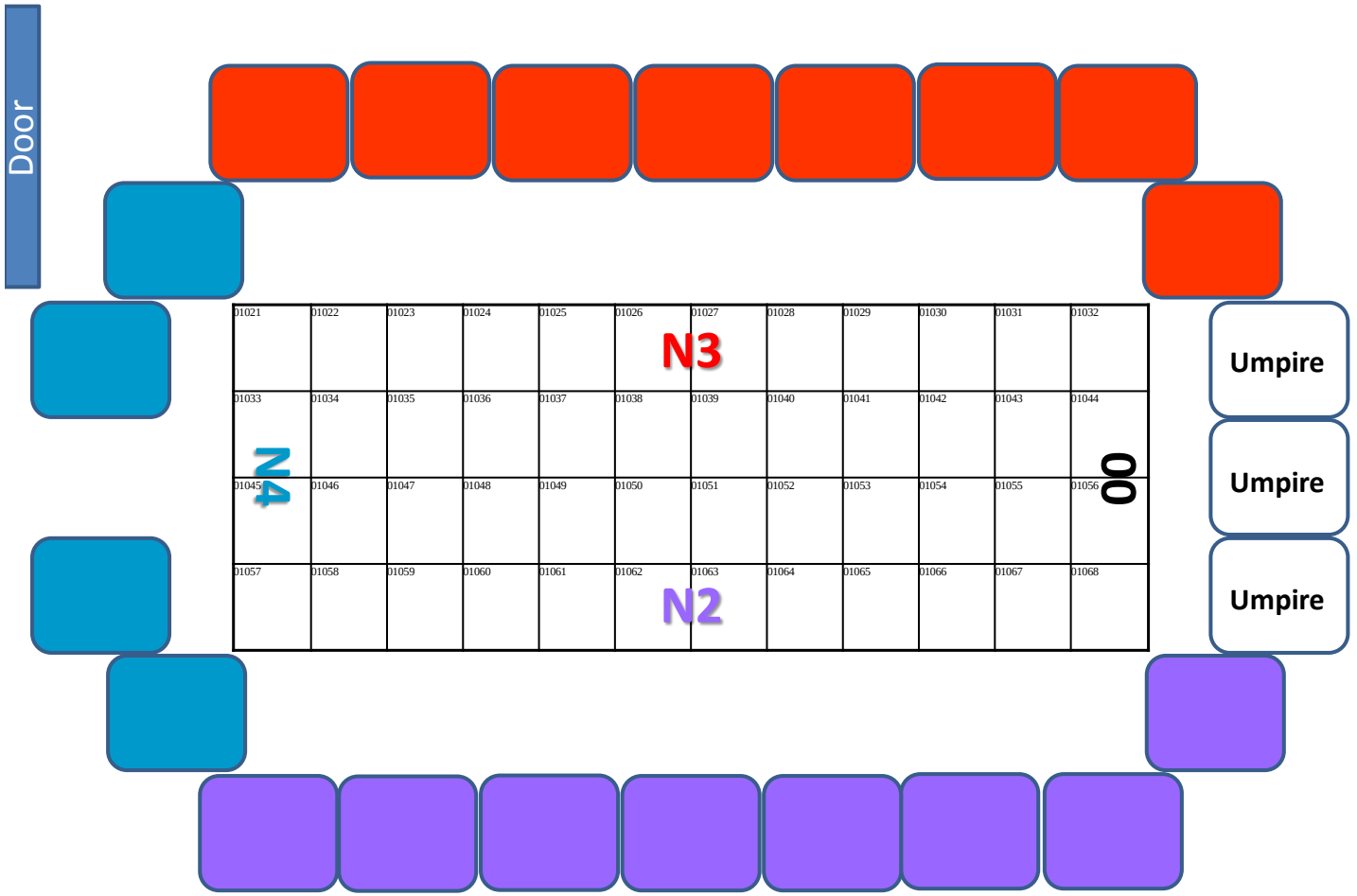
Using EXTAC 1000, encode the following basic signals:

MESSAGE	ENCODED SIGNAL
TAKE STATION 180° RELATIVE FROM THE GUIDE AT 2 NM	
WHEEL THE FORMATION TO THE RIGHT TO NEW COURSE 130° TRUE	
TAKE STATION 180° TRUE FROM THE GUIDE AT 5 NM	
TURN TOGETHER TO STARBOARD 40°	
ALTER THE DIRECTION OF THE SEARCH TO 190° T	
DECREASE SPEED BY 10 KNOTS	
BASE COURSE IS 000° T, BASE SPEED IS 15 KNOTS	
SHOW NO LIGHT	
REJOIN THE FORMATION WHEN PRESENT ORDERS HAVE BEEN CARRIED OUT	
PROCEED ON DUTY ASSIGNED	
MANEUVER INDEPENDENTLY TO AVOID ATTACK	
SUBMARINE SIGHTED BEARING 140° T AT 500 YARDS	
DEPTH OF SUBMARINE IS 100 FEET	

Battle of Midway War Game Rules

Standards: M(G&M)–10–7

Classroom Layout



Teams

Position	Period 3	Period 5	Period 6
Commander (00)			
COS (01)			
Intelligence (N2)			
Deputy (N2A)			
N2 Staff			
N2 Staff			
N2 Staff			
N2 Staff			
N2 Staff			
Operations (N3)			
Deputy (N3A)			
N3 Staff			
N3 Staff			
N3 Staff			
N3 Staff			
N3 Staff			
N3 Staff			
Logistics (N4)			
Deputy (N4A)			
N4 Staff			
N4 Staff			
N4 Staff			
N4 Staff			
N4 Staff			

War Game Sequence of Play

Time	Action	Responsibility
0:01	Display coded enemy intelligence disclosure on main screen.	Umpire
0:01 - 0:05	Brief team on outcome of previous move.	Umpire
0:05 - 0:15	N2 staff 1. Break coded enemy intelligence disclosure.	N2
0:05 - 0:15	N3 staff: 1. Begin preparation of Daily Briefing 2. Begin preparation of OPSUM Message 3. Schedule refueling requested by N4 to include location and time of rendezvous.	N3
0:05 - 0:15	N4 staff: 1. Determine fuel consumed last 24 hours - submit to N3 for inclusion in OPSUM 2. Identify any requests for refueling and submit request to N3.	N4
0:15 - 0:45	N2 Staff: 1. Begin to prepare encoded OPSUM message. 2. Submit intelligence input to N3 for inclusion into daily brief.	N2
0:15 - 0:45	N3 Staff: 1. Based upon intelligence received and previous day's turn outcome, develop air operations and surface operations plans for daily briefing to Admiral. 2. Advise N4 on movement intentions for next 24 hours. 3. Prepare daily OPSUM message and submit to N2 for encoding. 4. Begin preparation of daily briefing to Admiral.	N3
0:15 - 0:45	N4 Staff: 1. Determine latitude and longitude of task force. Submit to N3 for OPSUM. 2. Estimate fuel consumed next 24 hours for inclusion in OPSUM.	N4

0:45 - 0:55	Admiral's decision briefing. 1. Admiral approves recommendations of staff or modifies as desired. 2. Admiral advises umpire of decisions and basic strategy.	N2, N3, N4
0:55 - 0:60	1. Umpire, Commander, N-heads compile and submit daily grades. 2. N2: Finish encoding message for transmission. 3. N3 and N4 revise plans based upon Admiral's decisions.	N2, N3, N4

Procedures

1. There will be three teams:

   a. Period 3: Japanese Combined Fleet Striking Force
   b. Period 5: USN Task Force 16 / 17
   c. Period 6: USN Midway Defense Force

2. Each class period will be considered a team's turn.

3. Prior to the beginning of each turn, the umpire will ensure the game board is laid out reflecting that team's knowledge of the tactical situation.

4. At the beginning of each turn, the umpire will provide the team with the opponent's encoded OPSUM and will provide a summary of the outcome of the previous turn, to include:

   a. Outcome of any searches launched
   b. Outcome of any air strikes launched
   c. Points one or lost

5. Following the umpire brief, the Intelligence (N2) cell will work on decoding the opponent's OPSUM message. Once decoded, N2 will

immediately provide the decoded message to N3. Additionally, N2 will complete the following form and submit it to N3.

N2 Intelligence Analysis

_____
Date / Time

Enemy force estimated position: _____
Grid Coordinates

Enemy force estimated course / speed: _____

Enemy force estimated intentions:

Launch air strike against: _____

Continue search for our forces: _____

Alter course / speed to: _____

Additional notes: _____

_____

6. Once N2 had decoded the opponent's OPSUM, N2 will begin to encode its own team's OPSUM, using information provided to N3. The OPSUM must be encoded, submitted to the umpire, and approved by the umpire no later than 5 minutes prior to the end of the turn period or the umpire will release an un-encoded version to the opposing team at the beginning of that team's turn.

7. Following the umpire brief, the Logistics (N4) cell will determine the task force's position (latitude and longitude) and compute fuel consumption for the previous day and estimated fuel consumption for the

coming day. N4 will submit this information in the following format to N3:

N4 Logistics Briefing

Umpire will not approve unless all work is attached.

Number	Name	Max. fuel capacity	Amount used last 24 hours	% used last 24 hours	% remaining onboard	Projected use next 24 hours
Carrier 1						
Carrier 2						
Carrier 3						
Carrier 4						
NAS Fuel Farm						

Tanker Services Required? Yes / No

8. Following the umpire brief, N3 will do the following:

   a. Develop the air daily search plan, ensuring that no aircraft is allowed to exceed its combat radius on a search operation.
   b. Develop the air strike plan (if enemy forces have been located) ensuring that no aircraft is allowed to exceed its combat radius on a strike operation without specific approval of the Commander.
   c. Compile and prepare the Daily Commander's Brief.
   d. Compile and prepare the Daily Operations Summary / Intentions Message. The Commander must initial this message, approving it before it is encoded and presented to the Umpire.

N3 / NAS CO Air Operations Plan
(Search)

Number of aircraft to be launched: _____

Mission:

- Search

Search axis (degrees true from home base): Aircraft 1: _____

Aircraft 2: _____

Aircraft 3: _____

Aircraft 4: _____

Aircraft 5: _____

Range: __ _____ nm

Objective: _____

N3 / NAS CO Air Operations Plan
(Strike)

Umpire will not approve plan without work attached.

Number of aircraft to be launched: _____

Mission:

Objective: _____

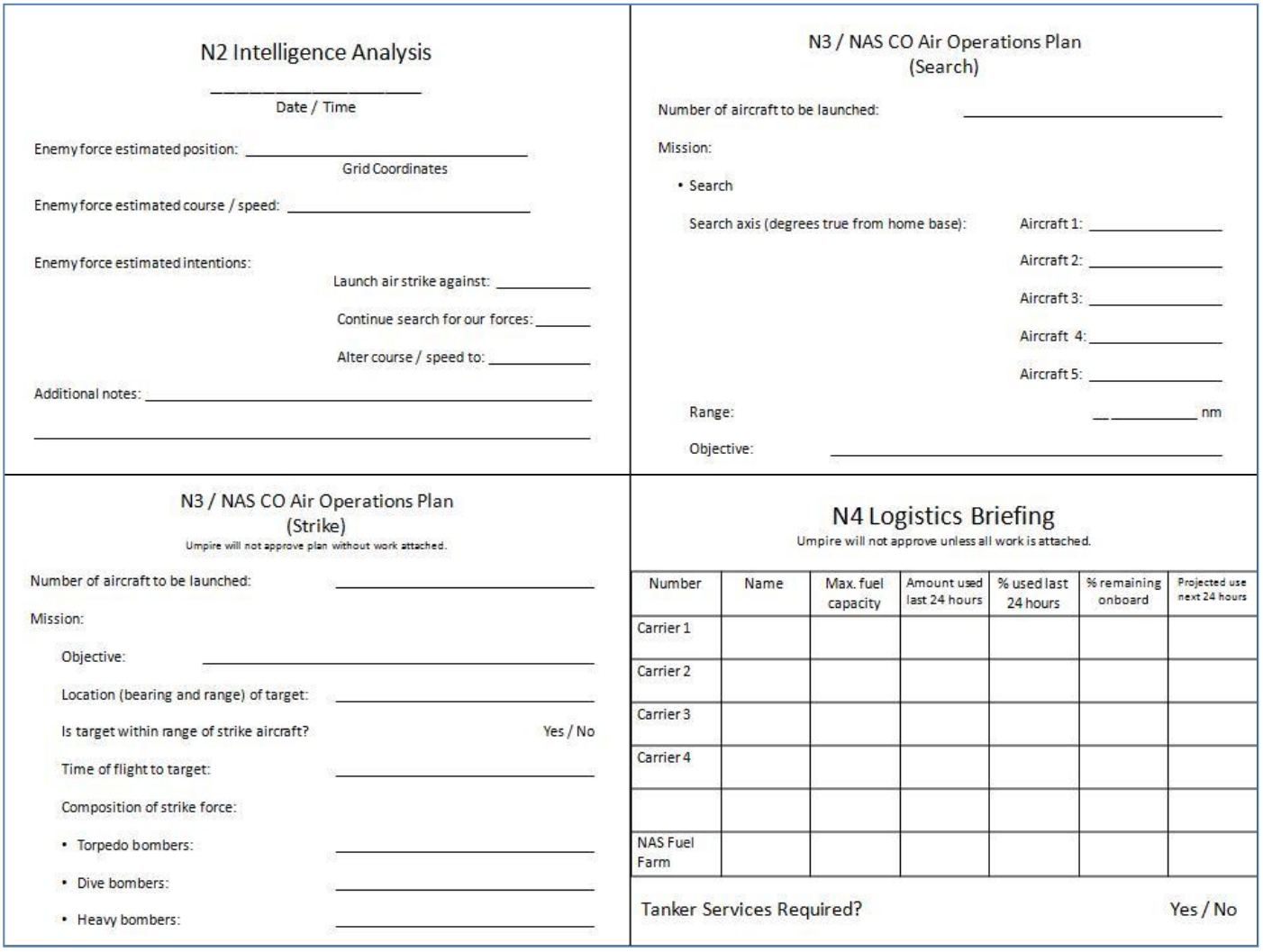
Location (bearing and range) of target: _____

Is target within range of strike aircraft? Yes / No

Time of flight to target: _____

Composition of strike force:

- Torpedo bombers: _____
- Dive bombers: _____
- Heavy bombers: _____



N2 Intelligence Analysis

_____
Date / Time

Enemy force estimated position: _____
Grid Coordinates

Enemy force estimated course / speed: _____

Enemy force estimated intentions:

Launch air strike against: _____

Continue search for our forces: _____

Alter course / speed to: _____

Additional notes: _____

_____

N3 / NAS CO Air Operations Plan
(Search)

Number of aircraft to be launched: _____

Mission:

- Search

Search axis (degrees true from home base):

Aircraft 1: _____

Aircraft 2: _____

Aircraft 3: _____

Aircraft 4: _____

Aircraft 5: _____

Range: _____ nm

Objective: _____

N3 / NAS CO Air Operations Plan
(Strike)

Umpire will not approve plan without work attached.

Number of aircraft to be launched: _____

Mission:

Objective: _____

Location (bearing and range) of target: _____

Is target within range of strike aircraft? Yes / No

Time of flight to target: _____

Composition of strike force:

- Torpedo bombers: _____
- Dive bombers: _____
- Heavy bombers: _____

N4 Logistics Briefing

Umpire will not approve unless all work is attached.

Number	Name	Max. fuel capacity	Amount used last 24 hours	% used last 24 hours	% remaining onboard	Projected use next 24 hours
Carrier 1						
Carrier 2						
Carrier 3						
Carrier 4						
NAS Fuel Farm						

Tanker Services Required? Yes / No

Daily Commander's Briefing

e. N3 will revise plans, messages, and the briefing as necessary upon receipt of valid intelligence of enemy intentions or in response to changes directed by the Commander or Chief of Staff.

9. Upon receipt of the Daily Commander's Briefing, the Commander will approve or modify the staff's recommendations, advise the umpire of his / her decisions, and advise the umpire of the team's basic strategy.

Scoring.

The umpire, upon receipt of the above information will score as follows:

1. Strategy Selection. The umpire will assign points to each team once that team's commander has selected his / her team's strategy for the day.

First Turn and End of Turn if Neither Side Detected

Americans → Japanese ↓	**Reinforce Midway**	**Split Forces**	**Search for and Attack Japanese**
Attack Midway	0	-100	-200
Split Forces	+100	0	-100
Search for and Attack Americans	+200	+100	0

End of Turn - Americans Detected

Americans → Japanese ↓	Reinforce Midway	Split Forces	Search for and Attack Japanese
Attack Midway	0	-100	-200
Split Forces	+200	+100	0
Search for and Attack Americans	+300	+200	+100

End of Turn - Japanese Detected

Americans → **Japanese ↓**	Reinforce Midway	Split Forces	Search for and Attack Japanese
Attack Midway	0	-200	-300
Split Forces	+100	-100	-200
Search for and Attack Americans	+200	0	-100

2. Outcome of Play.

Location of Enemy Force	**25 points**
Detailed Identification of Enemy Force	**25 points**
Successful Strike of Enemy Force	**50 points**
Destruction of Enemy Aircraft Carrier or Airfield.	**25 points**
All Players Focused and Involved in Game.	**100 points**

Team Member Evaluation

1. Students will evaluate each other's performance throughout the game as follows:

   a. The Umpire will evaluate the Commander.
   b. The Commander will evaluate the Chief of Staff and the N-heads.
   c. The N-heads will evaluate members of their teams.

2. Evaluation Rubric.

Student Name: _____

Date: _____

	4	3	2	1
Completion of assigned tasks		Team member completed all assigned tasks on time		Team member did not complete assign tasks on time
Quality of Work	Team member completed work correctly and was displayed it in a highly professional manner	Team member completed work correctly and displayed it neatly	Team member failed to complete work **or** work was sloppy and poorly presented	Team member failed to complete work **and** work was sloppy and poorly presented.
Team Contribution	Team member was focused, professional, and helped members of the team to succeed	Team member was focused and professional	Team member was unfocused (i.e. failed to concentrate on completing assigned tasks) **or** was unprofessional (i.e. failed to maintain positive demeanor, used foul language, acted in a boisterous manner.	Team member was unfocused **and** unprofessional

Add up the points and divide by 3. Final grade is: _____

3. Final grade will be an average of the grades of all four days of play. A final grade of less than 3 will result in failure of the war game exercise.

Daily OPSUM Message / Intelligence Disclosure

1. Each team will prepare a daily operations summary and commander's intentions (OPSUM) message in the following format:

From: Task Force Commander
To: Fleet Commander
Subj: Daily OPSUM and Commander's Intentions for _____ June 1942

Task force position:

(provide latitude and longitude and grid coordinate from game board)

Fuel onboard:
Carrier Gallons Percent

(list your aircraft carriers, the number of gallons each has onboard, and the percent of total fuel load remaining onboard)

Estimated fuel onboard:
Carrier Gallons Percent

(list your aircraft carriers, the number of gallons each will have onboard tomorrow at this time, and the percent of total fuel load remaining onboard tomorrow at this time)

Operations last 24 hours:

(list the numbers and types of aircraft launched for search and the results of the search and list the numbers and types of aircraft launched for strikes and the results of the strikes)

Intentions next 24 hours:

(list the following:
1. Numbers and types of aircraft to be launched for search
2. Area to be searched

3. *Numbers and types of aircraft to be launched for strike and the location and composition of the target to be struck*
4. *Where the task force will be (by grid number) at the beginning of the next turn)*

2. The umpire must approve the OPSUM before it is encoded.

3. The OPSUM can be encoded in any number of ways using techniques we learned in class.

    a. Encoding using arithmetic operations is limited to addition, subtraction, multiplication, division, and raising to the 1st, 2nd, or 3rd powers.
    b. EXTAC 1000 may be used to encode the message.
    c. Difficulty may also be increased by removing word spaces and line returns in the message.

4. The umpire must approve the encoded message before it is accepted.

5. If the team fails to encode the message on time and properly, the umpire will release an un-encoded message to the opposing team(s).

6. Below is an example of an encoded message using Microsoft EXCEL.

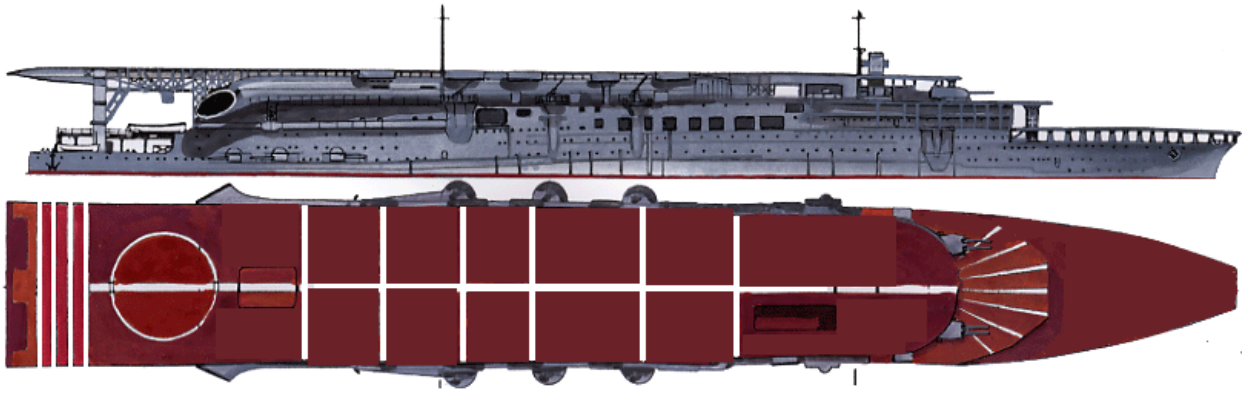
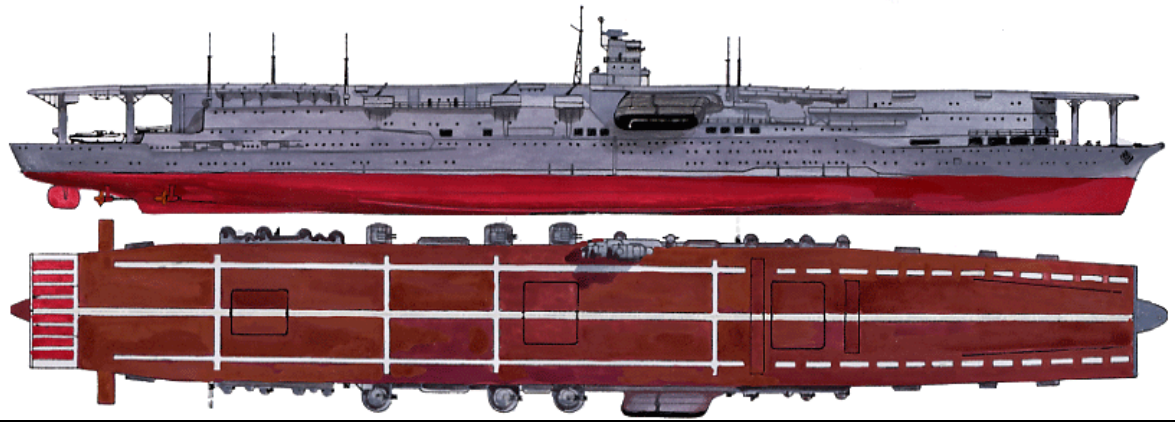
Message to be Coded																							
F	r	o	m	:	T	a	s	k		F	o	r	c	e		C	o	m	m	a	n	d	e	r
T	o	:		F	l	e	e	t		C	o	m	m	a	n	d	e	r						
S	u	b	j	:		D	a	i	l	y		O	P	S	U	M		a	n	d				
C	o	m	m	a	n	d	e	r	'	s		I	n	t	e	n	t	i	o	n	s			
f	o	r				J	u	n	e		1	9	4	2										
T	a	s	k		f	o	r	c	e		p	o	s	i	t	i	o	n	:					
28.2	N	177.35	W																					
F	u	e	l		o	n	b	o	a	r	d	:												
C	a	r	r	i	e	r				G	a	l	l	o	n	s		P	e	r	c	e	n	t
E	N	T	E	R	P	R	I	S	E	150	M	I	L	L	I	O	N		100					
H	O	R	N	E	T					150	M	I	L	L	I	O	N		100					
Y	O	R	K	T	O	W	N			150	M	I	L	L	I	O	N		100					
E	s	t	i	m	a	t	e	d		f	u	e	l		o	n	b	o	a	r	d	:		
C	a	r	r	i	e	r				G	a	l	l	o	n	s		P	e	r	c	e	n	t
E	N	T	E	R	P	R	I	S	E	145	M	I	L	L	I	O	N		97					
H	O	R	N	E	T					145	M	I	L	L	I	O	N		97					
Y	O	R	K	T	O	W	N			145	M	I	L	L	I	O	N		97					
I	n	t	e	n	t	i	o	n	s		n	e	x	t		2	4		h	o	u	r	s	:
C	o	n	t	i	n	u	e		e	n	r	o	u	t	e		P	o	i	n	t			
L	u	c	k																					

Encoded Message in Final Form with No Spaces																
1296	6250000	4879681	4100625	1296	160000	1185921	6765201	3418801	1296	4879681	6250000	1500625	1874161	81	4879681	4100625
160000	4100625	1185921	4477456	1679616	1874161	6250000	4879681	1296	1296	3748096	1874161	1874161	7311616	81	4879681	4100625
4100625	1185921	4477456	1679616	1874161	6250000	130321	7890481	1336336	3111696	1296	256	1185921	2825761	3748096	1.1E+07	50625
65536	130321	194481	28561	1185921	4477456	1679616	81	4879681	4100625	4100625	1185921	4477456	1679616	1874161	6250000	390625
6765201	6561	4477456	7311616	1874161	4477456	7311616	2825761	4879681	4477456	6765201	2085136	4879681	6250000	10000	7890481	4477456
1874161	50625	2401	20736	38416	160000	1185921	6765201	3418801	2085136	4879681	6250000	1500625	1874161	5308416	4879681	6765201
2825761	7311616	2825761	4879681	4477456	1296	632407	14	9.9E+08	23	1296	7890481	1874161	3748096	4879681	4477456	1336336
4879681	1185921	6250000	1679616	1296	81	1185921	6250000	6250000	2825761	1874161	6250000	2401	1185921	3748096	3748096	4879681
4477456	6765201	65536	1874161	6250000	1500625	1874161	4477456	7311616	625	38416	160000	625	104976	65536	104976	6561
130321	625	5.1E+08	28561	6561	20736	20736	6561	50625	38416	1E+08	4096	50625	104976	38416	625	160000
5.1E+08	28561	6561	20736	20736	6561	50625	38416	1E+08	390625	50625	104976	14641	160000	50625	279841	38416
5.1E+08	28561	6561	20736	20736	6561	50625	38416	1E+08	625	6765201	7311616	2825761	4100625	1185921	7311616	1874161
1679616	2085136	7890481	1874161	3748096	4879681	4477456	1336336	4879681	1185921	6250000	1679616	1296	81	1185921	6250000	6250000
2825761	1874161	6250000	2401	1185921	3748096	3748096	4879681	4477456	6765201	65536	1874161	6250000	1500625	1874161	4477456	7311616
625	38416	160000	625	104976	65536	104976	6561	130321	625	4.4E+08	28561	6561	20736	20736	6561	50625
38416	8.9E+07	4096	50625	104976	38416	625	160000	4.4E+08	28561	6561	20736	20736	6561	50625	38416	8.9E+07
390625	50625	104976	14641	160000	50625	279841	38416	4.4E+08	28561	6561	20736	20736	6561	50625	38416	8.9E+07
9834496	7311616	38416	20736	2560000	2825761	4477456	7311616	4879681	7890481	6250000	6765201	1296	6561	4477456	7311616	1874161
4477456	7311616	2825761	4879681	4477456	6765201	4477456	1874161	81	4879681	4477456	7311616	2825761	4477456	7890481	1874161	1874161
4477456	6250000	4879681	7890481	7311616	1874161	65536	4879681									

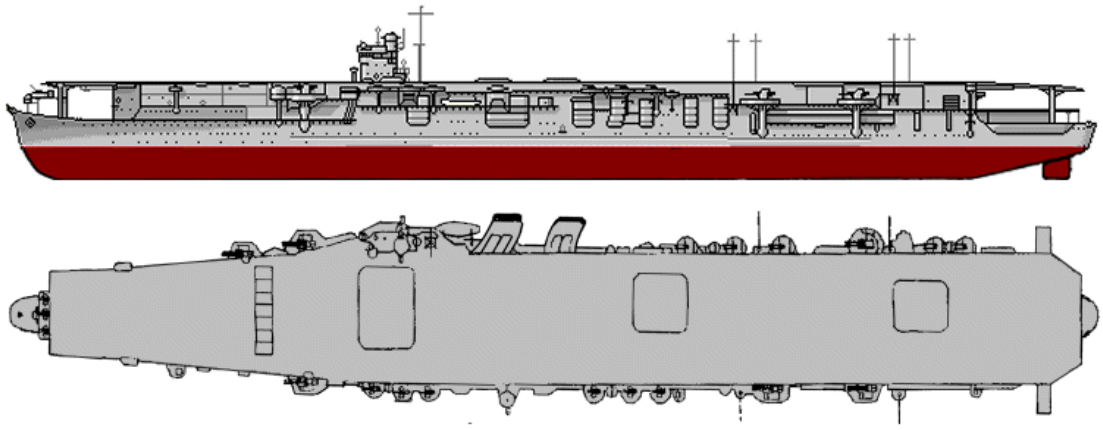
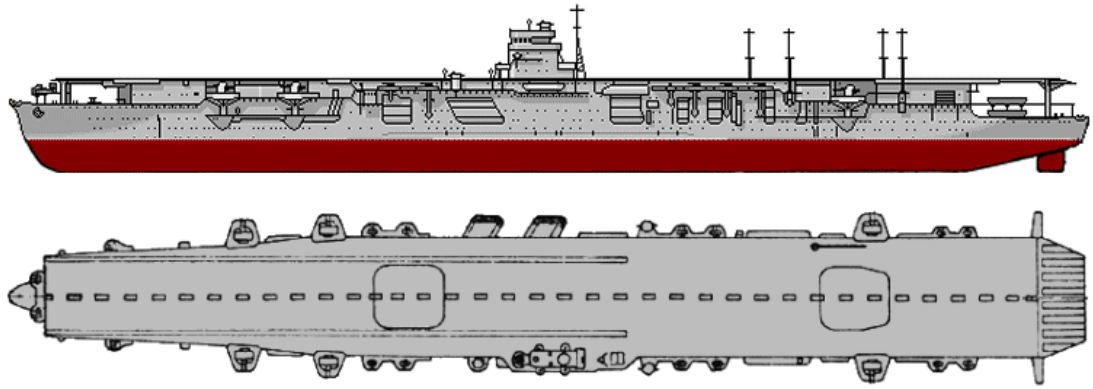
Ship and Aircraft Characteristics.

1. 機動部隊 (Japanese Mobile Striking Force).[5]

a. **Ships.** The speed and fuel consumption of the Japanese strike force will be based upon the characteristics of the four aircraft carriers of the *Kido Butai*. If operating together, the group can travel no faster than *Kaga's* maximum speed of 28 knots.

Ship	Max Speed	Max. Fuel Load	Consumption Rate
加賀 ***(Kaga)*** FL Disp. 42,541 tons	28 knots	1,666,666 gallons	at 15 knots: 166.67 gallons/nm
			
赤城 ***(Akagi)*** FL Disp. 41,300 tons	31.5 knots	1,562,500 gallons	at 16 knots: 156.25 gallons/nm
			

[5] Jonathan Parshall and Anthony Tully, *Shattered Sword: The Untold Story of the Battle of Midway* (Washington: Potomac Books, 2005), 462 – 486.

惣流 ***(Soryu)*** FL Disp. 19,800 tons	34.5 knots	1,092,593 gallons	at 18 knots: 142.45 gallons/nm
			
飛龍 ***(Hiryu)*** FL Disp. 21,900 tons	34.5 knots	1,092,593 gallons	at 18 knots: 142.45 gallons/nm
			

b. **Carrier Aircraft.** P(hit) is the probability that the weapon will strike its target based upon performance in the actual battle.

Type	Name	Cruising Range	Cruising Speed	Max. Speed	Armament	P(hit)[6]
Fighter	A6M2 / 21 "Zero"	1010 nm	179.88 nm / hr	287.63 nm / hr	Machine guns / canon	
Torpedo Bomber	B5N2 "Kate"	528 nm	139.91 nm / hr	204.21 nm / hr	800 kg of bombs or torpedoes	2/6
Dive Bomber	D3A1 "Val"	795 nm	159.89 nm / hr	208.55 nm / hr	370 kg of bombs	2/6

[6] Beall, 53.

c. **Search Aircraft.**

Name	Cruising Range	Cruising Speed	Max. Speed
E13A "Jake"	1128 nm	119.92 nm / hr	203.34 nm / hr
E8N2 "Dave"	485 nm		161.63 nm / hr

2. **U.S. Task Forces 16 and 17 and Midway Forces.**

a. **Ships.**[7] The speed and fuel consumption of the U.S. task forces will be based upon the characteristics of the three aircraft carriers.

Ship	FL Disp.	Max Speed	Max. Fuel Load	Consumption Rate
Yorktown (CV 5)	25,500 tons	32.5 knots	1,500,000 gallons	at 15 knots: 144.23 gallons/nm at 20 knots: 189.87 gallons/nm
Enterprise (CV 6)	25,500 tons	32.5 knots	1,500,000 gallons	at 15 knots: 144.23 gallons/nm at 20 knots: 189.87 gallons/nm
Hornet (CV 8)	25,500 tons	32.5 knots	1,500,000 gallons	at 15 knots: 144.23 gallons/nm at 20 knots: 189.87 gallons/nm

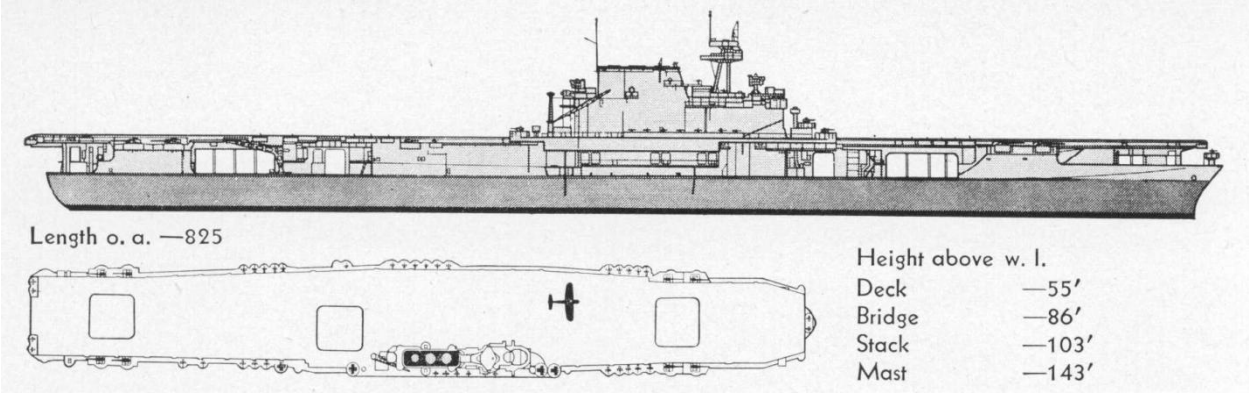


Figure 10 – *Yorktown* Class Aircraft Carrier

[7] "USS ENTERPRISE CV-6: The Most Decorated Ship Of The Second World War," accessed online May 28, 2012 at http://www.cv6.org/ship/big_e.htm.

b. **Carrier Aircraft.**[8] P(hit) is the probability that the weapon will strike its target based upon performance in the actual battle.

Type	Name	Cruising Range	Cruising Speed	Max. Speed	Armament	P(hit)[9]
Fighter	F4F-3 "Wildcat"	1690 nm (with drop tanks)		287.63 nm / hr	Machine guns	
Torpedo Bomber	TBD-1 "Devastator"	435 nm	111.23 nm / hr	179.00 nm / hr	454 kg of bombs or torpedoes	1/6
Dive Bomber	SBD-3 "Dauntless"	1130 nm	130.35 nm / hr	204.21 nm / hr	544 kg of bombs	2/6

c. **Long Range Aircraft.**[10]

Name	Cruising Range	Cruising Speed	Max. Speed	P(hit)
PBY-5 "Catalina"	3100 nm		170.32 nm / hr	
B-17E "Flying Fortress"	1737.95 nm	182.49 nm / hr	275.47 nm / hr	1/6

[8] "The Pacific War Online Encyclopedia," accessed online May 28, 2012 at http://pwencycl.kgbudge.com/Table_Of_Contents.htm.
[9] Beall, 53
[10] "The Pacific War Online Encyclopedia."

Fleet Aircraft Carriers

COMPARISON TABLE





	Akagi, 赤城		Kaga, 加賀		Sōryū, 蒼龍		Hiryū, 飛龍		Yorktown class	
Displacement:	41,300 t (36,500 t Std)		42,541 t (38,200 t Std)		18,800 t (15,900 t Std)		20,250 t (17,300 t Std)		25,500 t (19,800 t Std)	
Max Length:	855 ft 3 in	260.7 m	812 ft 6 in	247.7 m	746 ft 5 in	227.5 m	745 ft 11 in	227.3 m	809 ft 6 in	246.7 m
Beam:	102 ft 9 in	31.3 m	106 ft 8 in	32.5 m	69 ft 11 in	21.3 m	73 ft 3 in	22.3 m	109 ft 6 in	33.4 m
Draght:	28 ft 7 in	8.7 m	31 ft 1 in	9.5 m	25 ft 0 in	7.6 m	25 ft 9 in	7.7 m	25 ft 11 in	7.9 m
Machinery:	19 boilers, 4 shafts		8 boilers, 4 shafts		8 boilers, 4 shafts		8 boilers, 4 shafts		9 boilers, 4 shafts	
Max Power:	133,000 hp	97 821 kW	127,400 hp	95 000 kW	152,000 hp	113 336 kW	153,000 hp	114 092 kW	120,000 hp	89 483 kW
Max Speed:	31.25 kts	57.88 km/h	28.5 kts	52.78 km/h	34.5 kts	63.89 km/h	34.5 kts	63.89 km/h	32.5 kts	60.2 km/h
Range:	8,200 nm	15 186 km	10,000 nm	18 520 km	7,750 nm	14 353 km	10,330 nm	19 131 km	12,500 nm	23 150 km
Flight Deck:	817 ft 6 in	249 m	815 ft 6 in	248.5 m	711 ft 6 in	216.8 m	711 ft 6 in	216.8 m	802 ft	244.5 m
Fighters:	27 × A6M2 Type 0		27 × A6M2 Type 0		27 × A6M2 Type 0		27 × A6M2 Type 0		27 × F4F-4 Wildcat	
Bombers:	18 × D3A1 Type 99		27 × D3A1 Type 99		18 × D3A1 Type 99		18 × D3A1 Type 99		36 × SBD-3 Dauntless	
Attack:	27 × B5N2 Type 97		27 × B5N2 Type 97		18 × B5N2 Type 97		18 × B5N2 Type 97		15 × TBD-1 Devastator	
Armor (belt):	6 in	154 mm	6 in	154 mm	1.8 in	46 mm	1.8 in	46 mm	4 in	104 mm
SP Guns:	6 × 1 × 8 in (203 mm)/50		10 × 1 × 8 in (203 mm)/50		—		—		—	
DP Guns:	6 × 2 × 4.7 in (120 mm)/45		8 × 2 × 5 in (127 mm)/40		6 × 2 × 5 in (127 mm)/40		6 × 2 × 5 in (127 mm)/40		8 × 1 × 5 in (127 mm)/38	
AA Guns:	14 × 2 × 0.98 in (25 mm)		11 × 2 × 0.98 in (25 mm)		14 × 2 × 0.98 in (25 mm)		9 × 3 × 0.98 in (25 mm) 3 × 2 × 0.98 in (25 mm)		4 × 4 × 1.1 in (28 mm) 24/32 × 1 × 0.79 in (20 mm)	

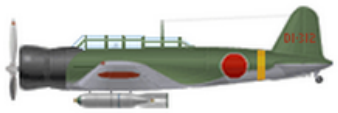
* *Akagi* and *Kaga* specifications as reconstructed at 1934-38.
** IJN carriers aircraft as in the largest known Air Groups ever carried (during the Pearl Harbor raid).
*** *Yorktown* class carriers light anti-aircraft armament: CV-5 - 24, CV-6 - 32, CV-8 - 30×1×0.79 in (20 mm)

Carrier Torpedo Bombers

COMPARISON TABLE

TBD-1

TBF-1



B5N1

B5N2

Manufacturer:	Douglas Aircraft Company		Grumman Aircraft Engineering Corp		Nakajima Aircraft Industries Ltd.		Nakajima Aircraft Industries Ltd.	
Length:	35 ft	10.6 m	40 ft	12.1 m	33 ft 9 in	10.3 m	33 ft 9 in	10.3 m
Height:	15 ft 3 in	4.60 m	16 ft 5 in	5.00 m	12 ft 2 in	3.70 m	12 ft 2 in	3.70 m
Wingspan:	50 ft	15.2 m	54 ft 2 in	16.5 m	50 ft 11 in	15.52 m	50 ft 11 in	15.52 m
Wingarea:	422 sq ft	39.2 m^2	490 sq ft	45.5 m^2	406 sq ft	37.70 m^2	406 sq ft	37.70 m^2
Empty Weight:	5,600 lb	2539 kg	10,555 lb	4,786 kg	4,643 lb	2106 kg	5,024 lb	2279 kg
Gross Weight:	10,194 lb	4623 kg	16,412 lb	7443 kg	8,157 lb	3700 kg	8,380 lb	3800 kg
Fuel Capacity:	180 gal	682 L	335 gal	1268 L	306 gal	1160 L	306 gal	1160 L
Power Plant:	Pratt & Whitney R-1830-64		Wright R-2600-8 Cyclone 14		Nakajima Hikari 3		Nakajima NK1B Sakae 11	
Military Power:	900 hp	671 kW	1700 hp	1268 kW	840 hp	626 kW	1000 hp	746 kW
Power/Weight:	0.09 hp/lb	0.19 hp/kg	0.10 hp/lb	0.23 hp/kg	0.10 hp/lb	0.23 hp/kg	0.12 hp/lb	0.26 hp/kg
Max Speed:	178 kts	331 km/h	223 kts	413 km/h	199 kts	369 km/h	205 kts	378 km/h
Cruise Speed:	110 kts	206 km/h	132 kts	246 km/h	138 kts	256 km/h	140 kts	259 km/h
Rate of Climb:	720 ft/min	219 m/min	1,430 ft/min	435 m/min	1,256 ft/min	383 m/min	1,284 ft/min	390 m/min
Service Ceiling:	19,700 ft	6000 m	21,400 ft	6500 m	24,280 ft	7400 m	27,100 ft	8260 m
Combat Range:	380 nm	705 km	865 nm	1600 km	588 nm	1090 km	530 nm	980 km
Guns:	1× .30 (7.62 mm) forward 1(2)× .30 (7.62 mm) rearward		1× .30 (7.62 mm) forward 1× .50 (12.7 mm), 1×.30 rearward		1× .303 (7.7 mm) rearward		1× .303 (7.7 mm) rearward	
Torpedo:	1× Mark 13 - 1,927 lb (874 kg)		1× Mark 13 - 1,927 lb (874 kg)		1× Type 91 - 1,872 lb (849 kg)		1× Type 91 - 1,872 lb (849 kg)	
Bomb Load:	Up to 1,000 lb (454 kg)		Up to 2,600 lb (1180 kg)		Up to 1,775 lb (805 kg)		Up to 1,775 lb (805 kg)	

Carrier Dive Bombers

COMPARISON TABLE

	SB2U-3		SBD-2		SBD-3		D3A1	
Manufacturer:	Chance Vought Aircraft		Douglas Aircraft Company		Douglas Aircraft Company		Aichi Aircraft Company	
Length:	34 ft	10.36 m	32 ft 1 in	9.79 m	32 ft 8 in	9.96 m	33 ft 5 in	10.2 m
Height:	10 ft 3 in	3.12 m	13 ft 7 in	4.14 m	13 ft 7 in	4.14 m	12 ft 8 in	3.85 m
Wingspan:	42 ft	12.8 m	41 ft 6 in	12.66 m	41 ft 6 in	12.66 m	47 ft 2 in	14.4 m
Wingarea:	305 sq ft	28.34 m^2	325 sq ft	30.19 m^2	325 sq ft	30.19 m^2	375.6 sq ft	34.9 m^2
Empty Weight:	5,634 lb	2556 kg	5,652 lb	2564 kg	6,345 lb	2878 kg	5,309 lb	2410 kg
Gross Weight:	7,474 lb	3390 kg	10,360 lb	4699 kg	10,400 lb	4717 kg	8,047 lb	3650 kg
Fuel Capacity:	130 gal	492 L	310 gal	1173 L	260 gal	984 L	285 gal	1079 L
Power Plant:	Pratt & Whitney R-1535-02		Wright R-1820-32 Cyclone 9		Wright R-1820-52 Cyclone 9		Mitsubishi Kinsei 44	
Military Power:	825 hp	615 kW	1000 hp	746 kW	1000 hp	746 kW	1,070 hp	798 kW
Power/Weight:	0.11 hp/lb	0.24 hp/kg	0.09 hp/lb	0.21 hp/kg	0.10 hp/lb	0.23 hp/kg	0.13 hp/lb	0.29 hp/kg
Max Speed:	211 kts	390 km/h	222 kts	412 km/h	217 kts	402 km/h	210 kts	390 km/h
Cruise Speed:	130 kts	244 km/h	128 kts	237 km/h	135 kts	250 km/h	160 kts	296 km/h
Rate of Climb:	1,070 ft/min	326 m/min	1,080 ft/min	330 m/min	1,190 ft/min	363 m/min	1,540 ft/min	469 m/min
Service Ceiling:	23,600 ft	7190 m	26,000 ft	7925 m	27,100 ft	8260 m	30,500 ft	9300 m
Combat Range:	973 nm	1800 km	1,065 nm	1970 km	1,175 nm	2175 km	795 nm	1472 km
Guns:	1× .50 (12.7 mm) forward 1× .50 (12.7 mm) rearward		2× .50 (12.7 mm) forward 1× .30 (7.62 mm) rearward		2× .50 (12.7 mm) forward 2× .30 (7.62 mm) rearward		2× .303 (7.7 mm) forward 1× .303 (7.7 mm) rearward	
Bomb Load:*	1× Mk. 12 - 500 lb (227 kg)		1× Mk. 13 - 1,000 lb (454 kg) or 1× Mk. 12 - 500 lb (227 kg)		1× Mk. 13 - 1,000 lb (454 kg) or 1× Mk. 12 - 500 lb (227 kg) and 2× Mk. 11 - 100 lb (45.4 kg)		1× Type 98 #25 - 534 lb (242 kg) or 1× Type 99 #25 - 553 lb (251 kg)	

* Used during the Battle of Midway

Carrier Fighters

COMPARISON TABLE

F2A-3

F4F-3

F4F-4

A6M2b

Manufacturer:	Brewster Aeronautical Corporation		Grumman Aircraft Engineering Corporation				Mitsubishi Aircraft Company	
Length:	26 ft 4 in	8.0 m	28 ft 9 in	8.76 m	28 ft 9 in	8.76 m	29 ft 9 in	9.06 m
Height:	12 ft	3.65 m	11 ft 10 in	3.60 m	9 ft 2 in	2.80 m	10 ft	3.05 m
Wingspan:	35 ft	10.6 m	38 ft	11.6 m	38 ft	11.6 m	39 ft 4 in	12.0 m
Wingarea:	209 sq ft	19.4 m^2	260 sq ft	24 m^2	260 sq ft	24 m^2	241 sq ft	22.44 m2
Empty Weight:	4,732 lb	2146 kg	5,342 lb	2422 kg	5,758 lb	2611 kg	3,704 lb	1680 kg
Gross Weight:	6,321 lb	2867 kg	7,000 lb	3175 kg	7,406 lb	3358 kg	5,313 lb	2410 kg
Fuel Capacity:	160 gal	605 L	144 gal	545 L	144 gal	545 L	144 (231*) gal	545 (875*) L
Power Plant:	Wright R-1820-40 Cyclone 9		Pratt & Whitney R-1830-76		Pratt & Whitney R-1830-86		Nakajima NK1C Sakae 12	
Military Power:	1200 hp	895 kW	1200 hp	895 kW	1200 hp	895 kW	950 hp	709 kW
Power/Weight:	0.19 hp/lb	0.42 hp/kg	0.17 hp/lb	0.38 hp/kg	0.16 hp/lb	0.36 hp/kg	0.18 hp/lb	0.39 hp/kg
Max Speed:	278 kts	515 km/h	286 kts	531 km/h	278 kts	515 km/h	287 kts	534 km/h
Cruise Speed:	140 kts	259 km/h	128 kts	237 km/h	128 kts	237 km/h	180 kts	333 km/h
Rate of Climb:	2,290 ft/min	698 m/min	2,265 ft/min	690 m/min	1,950 ft/min	594 m/min	3,100 ft/min	942 m/min
Service Ceiling:	33,200 ft	10 120 m	37,500 ft	11 430 m	34,000 ft	10 363 m	33,000 ft	10 000 m
Combat Range:	840 nm	1550 km	735 nm	1360 km	670 nm	1240 km	1,675 nm *	3100 km *
Nose Guns:	2 × .50 (12.7 mm), 750 rds **		—		—		2 × .303 (7.7 mm), 680 rds	
Wing Guns:	2 × .50 (12.7 mm), 450 rds		4 × .50 (12.7 mm), 430 rds		6 × .50 (12.7 mm), 240 rds		2 × .787 (20 mm), 60 rds	
Salvo Weight:	3.66 lb/sec	1.66 kg/sec	5.41 lb/sec	2.45 kg/sec	8.12 lb/sec	3.68 kg/sec	5.06 lb/sec	2.29 kg/sec

* With external 87.2 gal (330 L) drop tank, ** Allowance of ammunition, rounds per gun.

Briefing Templates

Intelligence Analysis

_____

Date / Time

Enemy force estimated position: _____

Grid Coordinates

Enemy force estimated course / speed: _____

Enemy force estimated intentions:

Launch air strike against: _____

Continue search for our forces: _____

Alter course / speed to: _____

Additional notes: _____

_____

N3 / NAS CO Air Operations Plan
(Search)

Number of aircraft to be launched: _____

Mission:

- Search

  Search axis (degrees true from home base): Aircraft 1: _____

  Aircraft 2: _____

  Aircraft 3: _____

  Aircraft 4: _____

  Aircraft 5: _____

  Range: __ _____ nm

  Objective: _____

N3 / NAS CO Air Operations Plan
(Strike)

Umpire will not approve plan without work attached.

Number of aircraft to be launched: _____

Mission:

Objective: _____

Location (bearing and range) of target: _____

Is target within range of strike aircraft? Yes / No

Time of flight to target: _____

Composition of strike force:

- Torpedo bombers: _____
- Dive bombers: _____
- Heavy bombers: _____

N4 Logistics Briefing

Umpire will not approve unless all work is attached.

Number	Name	Max. fuel capacity	Amount used last 24 hours	% used last 24 hours	% remaining onboard	Projected use next 24 hours
Carrier 1						
Carrier 2						
Carrier 3						
Carrier 4						
NAS Fuel Farm						

Tanker Services Required? Yes / No

Intelligence Analysis

_____
Date / Time

Enemy force estimated position: _____
Grid Coordinates

Enemy force estimated course / speed: _____

Enemy force estimated intentions:

Launch air strike against: _____

Continue search for our forces: _____

Alter course / speed to: _____

Additional notes: _____

_____

N3 / NAS CO Air Operations Plan (Search)

Number of aircraft to be launched: _____

Mission:

- Search

Search axis (degrees true from home base):

Aircraft 1: _____

Aircraft 2: _____

Aircraft 3: _____

Aircraft 4: _____

Aircraft 5: _____

Range: _____ nm

Objective: _____

N3 / NAS CO Air Operations Plan (Strike)

Umpire will not approve plan without work attached.

Number of aircraft to be launched: _____

Mission:

Objective: _____

Location (bearing and range) of target: _____

Is target within range of strike aircraft? Yes / No

Time of flight to target: _____

Composition of strike force:

- Torpedo bombers: _____
- Dive bombers: _____
- Heavy bombers: _____

N4 Logistics Briefing

Umpire will not approve unless all work is attached.

Number	Name	Max. fuel capacity	Amount used last 24 hours	% used last 24 hours	% remaining onboard	Projected use next 24 hours
Carrier 1						
Carrier 2						
Carrier 3						
Carrier 4						
NAS Fuel Farm						

Tanker Services Required? Yes / No

Daily War Game Preparation Problems

Day 1:

A. U.S.S. *Yorktown* (CV – 5) burns the following amount of fuel per nautical mile:

144.23 gallons per nautical mile at 15 knots
189.7 gallon per nautical mile at 20 knots

Yorktown must travel 1300 nautical miles at 15 knots.

i. How much fuel will she burn?
ii. How long in hours will the voyage take?

B. In the following encoded message, the letter "a" or the letter "e" ***is the vowel that appears most often***. Decode the following message:

5 100 100 5 15 55 65 45 20 115 5 125

Day 2:

A. U.S.S. *Yorktown* (CV – 5) burns the following amount of fuel per nautical mile:

144.23 gallons per nautical mile at 15 knots
189.7 gallon per nautical mile at 20 knots

Yorktown must travel 450 nautical miles at 20 knots.

i. How much fuel will she burn?
ii. How long in hours will the voyage take?

B. In the following encoded message, the letter "a" or the letter "e" ***is the vowel that appears most often***. Decode the following message:

24 2 42 28 6 16 2 18 36 6 36 2 12 40

Day 3:

A. U.S.S. *Yorktown* (CV – 5) burns the following amount of fuel per nautical mile:

144.23 gallons per nautical mile at 15 knots
189.7 gallon per nautical mile at 20 knots

Yorktown must travel 130 nautical miles at 15 knots.

i. How much fuel will she burn?
ii. How long in hours will the voyage take?

B. In the following encoded message, the letter "a" or the letter "e" ***is the vowel that appears most often***. Decode the following message:

9 2.5 3 10.5 2.5 6 10 7.5 2 0.5 12.5

Day 4:

A. U.S.S. *Yorktown* (CV – 5) burns the following amount of fuel per nautical mile:

144.23 gallons per nautical mile at 15 knots
189.7 gallon per nautical mile at 20 knots

Yorktown must travel 573 nautical miles at 20 knots.

i. How much fuel will she burn?
ii. How long in hours will the voyage take?

B. In the following encoded message, the letter "a" or the letter "e" ***is the vowel that appears most often***. Decode the following message:

1 144 400 25 324 9 225 441 324 361 25

Day 5:

A. U.S.S. *Yorktown* (CV – 5) burns the following amount of fuel per nautical mile:

144.23 gallons per nautical mile at 15 knots
189.7 gallon per nautical mile at 20 knots

Yorktown must travel 573 nautical miles at 20 knots.

i. How much fuel will she burn?
ii. How long in hours will the voyage take?

B. In the following encoded message, ***no letter appears most often***. Decode the following message:

64 1 5832 1331 125 2744 6859 512 729 4096

Day 6:

A. Given the observed altitude of the Sun (O) and the declination of the Sun (D), Latitude (La) can be determined by the following formulae:

$La = 90° - O + D$ (Sun in the Northern Hemisphere)
$La = 90° - O - D$ (Sun in Southern Hemisphere)

Find La if:

$$O = 60°$$
$$D = 12°N$$

B. Decode the following message:

100 105 90 70 30 75 90 65 5 100 45 75 70

Day 7:

A. Given the observed altitude of the Sun (O) and the declination of the Sun (D), Latitude (La) can be determined by the following formulae:

$La = 90° - O + D$ (Sun in the Northern Hemisphere)
$La = 90° - O - D$ (Sun in Southern Hemisphere)

Find La if:

$$O = 55°$$
$$D = 15°N$$

B. Decode the following message:

4 324 25 1 121 9 225 196 400 1 9 400

Day 8:

A. Given the observed altitude of the Sun (O) and the declination of the Sun (D), Latitude (La) can be determined by the following formulae:

$La = 90° - O + D$ (Sun in the Northern Hemisphere)
$La = 90° - O - D$ (Sun in Southern Hemisphere)

Find La if:

$$O = 60°\ 12'$$
$$D = 12°N$$

B. Decode the following message:

36 10 28 8 10 44 30 42 38 2 40 0 32 30 18 28 40 2

Day 9:

A. Given the observed altitude of the Sun (O) and the declination of the Sun (D), Latitude (La) can be determined by the following formulae:

$La = 90° - O + D$ (Sun in the Northern Hemisphere)
$La = 90° - O - D$ (Sun in Southern Hemisphere)

Find La if:

$$O = 55° 12'$$
$$D = 12° 17'N$$

B. Decode the following message:

6 0.5 7 2 0.5 4.5 9 1.5 9 0.5 3 10

Day 10:

A. Given the observed altitude of the Sun (O) and the declination of the Sun (D), Latitude (La) can be determined by the following formulae:

$La = 90° - O + D$ (Sun in the Northern Hemisphere)
$La = 90° - O - D$ (Sun in Southern Hemisphere)

Find La if:

$$O = 68° 15'$$
$$D = 15° 19'N$$

B. Decode the following message:

81 196 9 324 25 1 361 25 361 256 25 25 16

Day 11:

A. Recall that to compute ***longitude*** in the ***Western Hemisphere*** you follow these steps:

(1) $Greenwich\ Mean\ Time\ of\ LAN\ (GMT\ of\ LAN) - 12{:}00 = h{:}mm$

(2) $$h \times \frac{15^\circ}{hour} = degrees\ west\ of\ 0^\circ\ longitude$$

(3) $$mm \div \frac{4'}{1^\circ} = additional\ degrees\ west\ of 0^\circ\ longitude$$

(4) $$add\ (2)\ and\ (3) together\ to\ get\ ship's\ west\ longitude$$

Find the west longitude if $GMT\ of\ LAN = 22{:}28.$

Day 12:

A. Recall that to compute ***longitude*** in the ***Western Hemisphere*** you follow these steps:

(2) $Greenwich\ Mean\ Time\ of\ LAN\ (GMT\ of\ LAN) - 12{:}00 = h{:}mm$

(2) $$h \times \frac{15^\circ}{hour} = degrees\ west\ of\ 0^\circ\ longitude$$

(3) $$mm \div \frac{4'}{1^\circ} = additional\ degrees\ west\ of 0^\circ\ longitude$$

(4) $$add\ (2)\ and\ (3) together\ to\ get\ ship's\ west\ longitude$$

Find the west longitude if $GMT\ of\ LAN = 22{:}50.$

Day 13:

A. Recall that to compute ***longitude*** in the ***Western Hemisphere*** you follow these steps:

(3) $Greenwich\ Mean\ Time\ of\ LAN\ (GMT\ of\ LAN) - 12{:}00 = h{:}mm$

(2) $h \times \frac{15^\circ}{hour} = degrees\ west\ of\ 0^\circ\ longitude$

(3) $mm \div \frac{4'}{1^\circ} = additional\ degrees\ west\ of 0^\circ\ longitude$

(4) $add\ (2)\ and\ (3) together\ to\ get\ ship's\ west\ longitude$

Find the west longitude if $GMT\ of\ LAN = 23{:}12.$

Day 14:

A. Recall that to compute ***longitude*** in the ***Western Hemisphere*** you follow these steps:

(4) $Greenwich\ Mean\ Time\ of\ LAN\ (GMT\ of\ LAN) - 12{:}00 = h{:}mm$

(2) $h \times \frac{15^\circ}{hour} = degrees\ west\ of\ 0^\circ\ longitude$

(3) $mm \div \frac{4'}{1^\circ} = additional\ degrees\ west\ of 0^\circ\ longitude$

(4) $add\ (2)\ and\ (3) together\ to\ get\ ship's\ west\ longitude$

Find the west longitude if $GMT\ of\ LAN = 23{:}44.$

Name: _____

Name: _____

War Game Practice Drill Number One
Show all work on separate sheets of paper.
If you complete, you get the points. If you do not complete, you lose the points

1. Your task force is in grid 01039 heading west at 15 knots.

2. Your receive the following coded message identifying the first target. Break the code (**1 point)**.

1728	1	5832	343	125		125	2744	125	2197	15625	
216	1728	125	125	8000		343	5832	729	64		1034
64	729	6859	8000	1	2744	27	125		854	2744	2197

3. Determine which aircraft you can send against this target. Use the tables on the large white board and circle the aircraft you want to use (you can use more than one type so long as each selected type can make it to the target) (**1 point)**:

   a. SB2U-3 Dive Bomber

   b. TBD-1 Torpedo Bomber

   c. F4F-3 Fighter

4. Determine how long it will take your selected aircraft to reach the target (use the Cruise Speed). **Do this only for the aircraft you selected in "3"** (**1 point**).

   Time to target in hours

   a. SB2U-3 Dive Bomber _____

   b. TBD-1 Torpedo Bomber _____

   c. F4F-3 Fighter _____

5. **Bonus Points (5 points):** Only the SB2U-3 Dive Bomber and the TBD-1 Torpedo Bomber can strike the target. You can take up to six of each if each can reach the target.

   a. The SB2U-3 has a probability of 0.5 that it will hit the target. The TBD-1 has a probability of 0.3 that it will hit the target. If you take 3 of each type, what is the probability that all will hit the target?

Name: _____

War Game Practice Drill Number Two
Show all work on separate sheets of paper.
If you complete, you get the points. If you do not complete, you lose the points

1. Your task force is in grid 01037 heading west at 15 knots.

2. Your receive a coded message identifying the first target. This message will be found in your team leader's school e-mail box.

3. Determine which aircraft you can send against this target. Use the tables on the large white board and circle the aircraft you want to use (you can use more than one type so long as each selected type can make it to the target). You need 2 dive bombers or 2 torpedo planes, or 1 of each to kill an aircraft carrier. Determine how many planes of each you want to take.

   Number

   a. SB2U-3 Dive Bomber _____

   b. TBD-1 Torpedo Bomber _____

   c. F4F-3 Fighter _____

4. Determine how long it will take your selected aircraft to reach the target (use the Cruise Speed). **Do this only for the aircraft you selected in "3"**.

   Time to target in hours

   a. SB2U-3 Dive Bomber _____

   b. TBD-1 Torpedo Bomber _____

   c. F4F-3 Fighter _____

5. **Bonus Points (5 points):** Only the SB2U-3 Dive Bomber and the TBD-1 Torpedo Bomber can strike the target. You can take up to six of each if each can reach the target.

    a. The SB2U-3 has a probability of 0.57 that it will hit the target. The TBD-1 has a probability of 0.29 that it will hit the target. If you take 4 of each type, what is the probability that all will hit the target?

_____

List all team members here and grade them (1, 2, 3, 4) on their work today:

Name	Grade
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

01021	01022	01023	01024	01025	01026	01027	01028	01029	01030	01031	01032
01033	01034	01035	01036	01037	01038	01039	01040	01041	01042	01043	01044
01045	01046	01047	01048	01049	01050	01051	01052	01053	01054	01055	01056
01057	01058	01059	01060	01061	01062	01063	01064	01065	01066	01067	01068

Coded Message Nr. 1

28561	1	38416	390625		625	38416	625	28561	390625		
81	1	104976	104976	6561	625	104976	130321		160000	279841	50625
16	1	160000	160000	20736	625	130321	4096	6561	65536	130321	
130321	6561	331776		81	104976	194481	6561	130321	625	104976	130321
1	38416	256		1296	6561	1296	160000	625	625	38416	
256	625	130321	160000	104976	50625	625	104976	130321		1	160000
2401	104976	6561	256		1035						
81	130321	625		625	1	130321	160000		1	160000	
23		14641	38416	50625	160000	130321					

Coded Message Nr. 2

2197	1	2744	15625		125	2744	125	2197	15625		
27	1	5832	5832	729	125	5832	6859		8000	12167	3375
8	1	8000	8000	1728	125	6859	512	729	4096	6859	
6859	729	13824		27	5832	9261	729	6859	125	5832	6859
1	2744	64		216	729	216	8000	125	125	2744	
64	125	6859	8000	5832	3375	125	5832	6859		1	8000
343	5832	729	64		1035						
27	6859	125		125	1	6859	8000		1	8000	
23		1331	2744	3375	8000	6859					

Coded Message Nr. 3

39	3	42	75		15	42	15	39	75		
9	3	54	54	27	15	54	57		60	69	45
6	3	60	60	36	15	57	24	27	48	57	
57	27	72		9	54	63	27	57	15	54	57
3	42	12		18	27	18	60	15	15	42	
12	15	57	60	54	45	15	54	57		3	60
320		42	39		69	15	60				
9	57	15		15	3	57	60		3	60	
23		33	42	45	60	57					

Coded Message Nr. 4

3.25	0.25	3.5	6.25		1.25	3.5	1.25	3.25	6.25		
0.75	0.25	4.5	4.5	2.25	1.25	4.5	4.75		5	5.75	3.75
0.5	0.25	5	5	3	1.25	4.75	2	2.25	4	4.75	
4.75	2.25	6		0.75	4.5	5.25	2.25	4.75	1.25	4.5	4.75
0.25	3.5	1		1.5	2.25	1.5	5	1.25	1.25	3.5	
1	1.25	4.75	5	4.5	3.75	1.25	4.5	4.75		0.25	5
-3.25		3.5	3.25		5.75	1.25	5				
0.75	4.75	1.25		1.25	0.25	4.75	5		0.25	5	
-3.5		2.75	3.5	3.75	5	4.75					

Name: _____

War Game Practice Drill Number Three
Show all work on separate sheets of paper.
If you complete, you get the points. If you do not complete, you lose the points

1. Your task force, with the carrier U.S.S. *Yorktown* is in grid 01049 heading west at 15 knots. Assume you have 80% fuel onboard.

2. Your receive a coded message from the Commander in Chief of the U. S. Pacific Fleet (CINCPACFLT). Directing you to move your ships to a new location to do something. Decode this message.

8000	1	8	8	-	4	-				
27	729	2744	27	4096	1	27	216	1728	8000	-
3375	4096	1728	1	2744		2	9	-	4	2
5832	6859	7	-	1						
8000	1	7	9	-	343	5832	729	64	"01051"	-
1	5	0	0	-	1728	3375	27	1	1728	-
4096	1728	1	8000	8000	1035					

3. Determine the course, speed you need to get to this new location on time. Determine how much fuel you have burned (gallons and percentage) when you get to the new location, and how much fuel you will need in gallons, to get to 100%.

Course: _____

Speed: _____

Time: _____

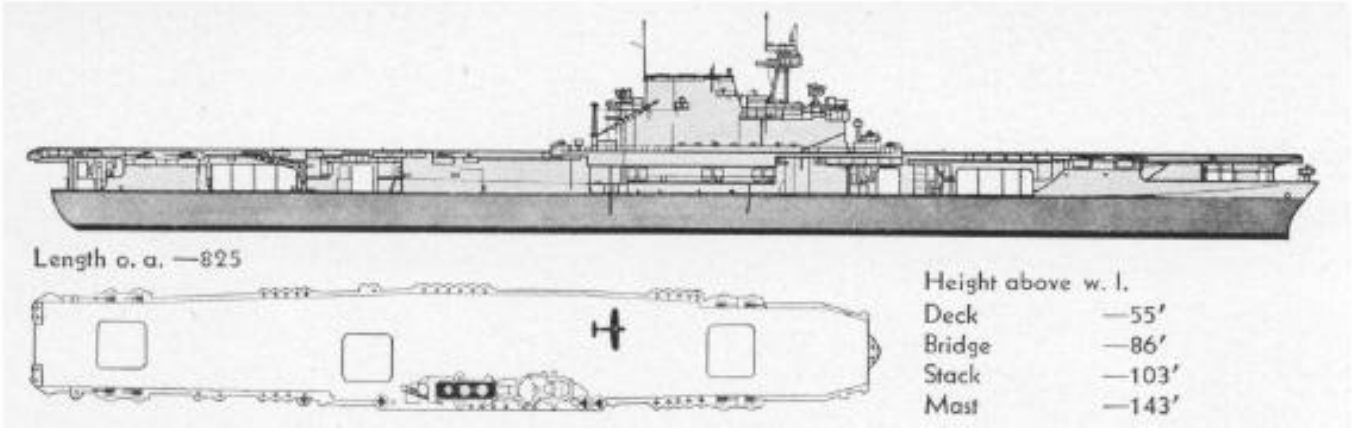
Fuel burned (gallons / percent) _____

Fuel needed (gallons) _____

List all team members here and grade them (1, 2, 3, 4) on their work today:

Name	Grade
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Ship	FL Disp.	Max Speed	Max. Fuel Load	Consumption Rate
Yorktown (CV 5)	25,500 tons	32.5 knots	1,500,000 gallons	at 15 knots: 144.23 gallons/nm at 20 knots: 189.87 gallons/nm
Enterprise (CV 6)	25,500 tons	32.5 knots	1,500,000 gallons	at 15 knots: 144.23 gallons/nm at 20 knots: 189.87 gallons/nm
Hornet (CV 8)	25,500 tons	32.5 knots	1,500,000 gallons	at 15 knots: 144.23 gallons/nm at 20 knots: 189.87 gallons/nm



01021	01022	01023	01024	01025	01026	01027	01028	01029	01030	01031	01032
01033	01034	01035	01036	01037	01038	01039	01040	01041	01042	01043	01044
01045	01046	01047	01048	01049	01050	01051	01052	01053	01054	01055	01056
01057	01058	01059	01060	01061	01062	01063	01064	01065	01066	01067	01068

Name: _____

War Game Practice Drill Number Four
Show all work on separate sheets of paper.
If you complete, you get the points. If you do not complete, you lose the points

1. You are commander of a Japanese force consisting of four aircraft carriers and many escort ships. You are located in grid 01046 on a course east at 18 knots.

2. You receive the following message:

敵は **480 NM** は東に見つけました。コース西。**25** ノットのスピード。二つの空母。多くの護衛船。爆撃と魚雷爆撃機で攻撃。

Translate the message and write the translation here. Team leaders will find this message in their e-mail.

_____

_____

_____

_____

_____

3. At your current speed, determine how many hours it will take for your ships to reach the target (**This is a trick question. Hint:** Remember, the target is moving toward you at a certain speed.

_____

4. Determine which aircraft you can send against this target. Use the tables on the large white board and circle the aircraft you want to use (you can use more than one type so long as each selected type can make it to the target). You need 2 dive bombers or 2 torpedo planes, or 1 of each to kill an aircraft carrier. Determine how many planes of each you want to take.

Number

a. D3A1 Dive Bomber _____

b. B5N1 Torpedo Bomber _____

c. A6M2b Fighter _____

5. Determine how long it will take your selected aircraft to reach the target (use the Cruise Speed). **Do this only for the aircraft you selected in "3"**.

Time to target in hours

a. D3A1 Dive Bomber _____

b. B5N1 Torpedo Bomber _____

c. A6M2b Fighter _____

6. List all team members here and grade them (1, 2, 3, 4) on their work today:

Name Grade

_____ _____

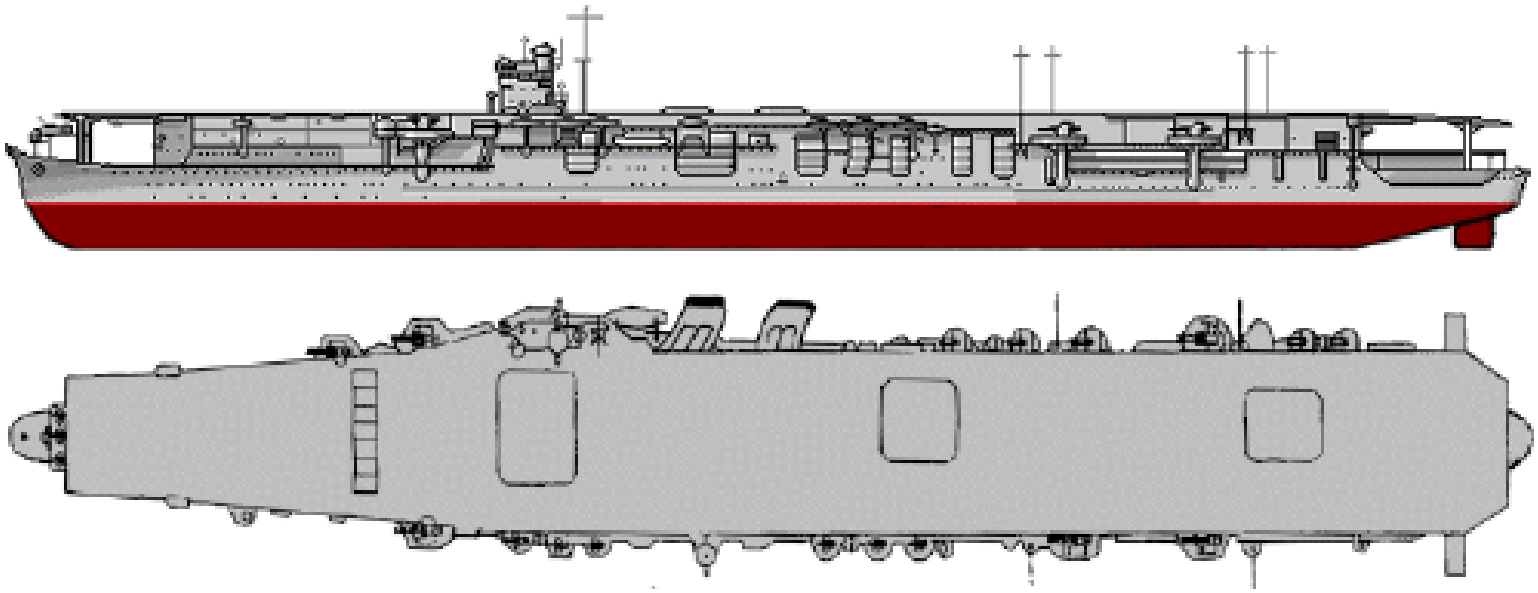
_____ _____

_____ _____

_____ _____

_____ _____

惣流 *(Soryu)* FL Disp. 19,800 tons	34.5 knots	1,092,593 gallons	at 18 knots: 142.45 gallons/nm



Game Board

01021	01022	01023	01024	01025	01026	01027	01028	01029	01030	01031	01032
01033	01034	01035	01036	01037	01038	01039	01040	01041	01042	01043	01044
01045	01046	01047	01048	01049	01050	01051	01052	01053	01054	01055	01056
01057	01058	01059	01060	01061	01062	01063	01064	01065	01066	01067	01068

Pre-Game Intelligence Disclosure 1

100	2916	2601	2401	4	576	1369	3025	2209		100	2601	2916	1521	1681		49	2601	2401	2401	1369	2500	1600	1681	2916
576	2601	4		100	2304	1681	1681	3136		49	2601	2401	2401	1369	2500	1600	1681	2916						
529	3249	1444	2116	4		64	1369	2025	2304	3721		361	400	529	625	289		1369	2500	1600				
49	2601	2401	2401	1369	2500	1600	1681	2916	441	3025		169	2500	3136	1681	2500	3136	2025	2601	2500	3025			
1764	2601	2916		2	3		289	1369	3721		1	9	4	2										
576	1369	3025	2209		1764	2601	2916	1521	1681		2704	2601	3025	2025	3136	2025	2601	2500	4					
121	2916	2025	1600		0	1	0	3	8															
100	3249	1681	2304		2601	2500	1444	2601	1369	2916	1600	4												
49	1369	2916	2916	2025	1681	2916				121	1369	2304	2304	2601	2500	3025		400	1681	2916	1521	1681	2500	3136
81	324	576	81	484	400	484	169	529	81	150	289	169	256	256	169	361	324		100					
144	361	484	324	81	576					150	289	169	256	256	169	361	324		100					
841	361	484	225	576	361	729	324			150	289	169	256	256	169	361	324		100					
81	3025	3136	2025	2401	1369	3136	1681	1600		1764	3249	1681	2304		2601	2500	1444	2601	1369	2916	1600	4		
49	1369	2916	2916	2025	1681	2916				121	1369	2304	2304	2601	2500	3025		400	1681	2916	1521	1681	2500	3136
81	324	576	81	484	400	484	169	529	81	145	289	169	256	256	169	361	324		97					
144	361	484	324	81	576					145	289	169	256	256	169	361	324		97					
841	361	484	225	576	361	729	324			145	289	169	256	256	169	361	324		97					
169	2500	3136	1681	2500	3136	2025	2601	2500	3025		2500	1681	3600	3136		2	4		1936	2601	3249	2916	3025	4
49	2601	2500	3136	2025	2500	3249	1681		1681	2500	2916	2601	3249	3136	1681		400	2601	2025	2500	3136			
256	3249	1521	2209																					

War Game Play and Outcome

Umpire Sheet - Day 1

1. Imperial Japanese Navy *Kido Butai*

   a. Location: Grid 01045
   b. Course: Northeast
   c. Speed: 18 knots
   d. Fuel Onboard (each carrier): 1,092,593 gallons
   e. Fuel Used Last 24 Hours 0
   f. Projected Use Next 24 Hours Speed * 24 * gallons burned / nm

2. Imperial Japanese Navy Midway Invasion Force

   a. Location: Grid 01035
   b. Course: East
   c. Speed: 18 knots

3. USN Task Force 16 (*Enterprise* and *Hornet*)

   a. Location: Grid 01025
   b. Course: West
   c. Speed: 15 knots
   d. Fuel Onboard (each carrier): 1,500,000 gallons
   e. Fuel Used Last 24 Hours 0
   f. Projected Use Next 24 Hours Speed * 24 * gallons burned / nm
   g.

4. USN Task Force 17 (*Yorktown*)

   a. Location: Grid 01038
   b. Course: Northwest
   c. Speed: 15 knots
   d. Fuel Onboard (each carrier): 1,500,000 gallons
   e. Fuel Used Last 24 Hours 0
   f. Projected Use Next 24 Hours Speed * 24 * gallons burned / nm

Intelligence Disclosures

To Japanese Forces:

-90	-108		54	84		18	6	108	108	150	54	84	42		90	126	120		120	48	30					
120	6	114	66		6	114	114	54	42	84	30	24		54	84		90	96	30	108	6	120	54	90	84
96	72	6	84		-84	-42	-114	-72	-84		150	90	126		138	54	72	72		12	30					
42	90	132	30	108	84	30	24		12	150		120	48	30		96	108	54	84	18	54	96	72	30		
90	36		18	6	72	18	126	72	6	120	30	24		108	54	114	66	-120		138	48	54	18	48		
150	90	126		114	48	6	72	72		54	84	120	30	108	96	108	30	120		120	90					
78	30	6	84		120	48	30		6	132	90	54	24	6	84	18	30		90	36						
30	144	96	90	114	126	108	30		90	36		150	90	126	108		36	90	108	18	30		120	90		
6	120	120	6	18	66		12	150		114	126	96	30	108	54	90	108		30	84	30	78	150			
36	90	108	18	30	114		138	54	120	48	90	126	120		42	90	90	24								
96	108	90	114	96	30	18	120		90	36		54	84	36	72	54	18	120	54	84	42	-120				
6	114	######	6	######	108	30	114	126	72	120		90	36		114	126	18	48								
30	144	96	90	114	126	108	30	-120		42	108	30	6	120	30	108		24	6	78	6	42	30			

1. IN CARRYING OUT THE TASK ASSIGNED IN OPERATION PLAN 29-42 YOU WILL BE GOVERNED BY THE PRINCIPLE OF CALCULATED RISK, WHICH YOU SHALL INTERPRET TO MEAN THE AVOIDANCE OF EXPOSURE OF YOUR FORCE TO ATTACK BY SUPERIOR ENEMY FORCES WITHOUT GOOD PROSPECT OF INFLICTING, AS A RESULT OF SUCH EXPOSURE, GREATER DAMAGE TO THE ENEMY.

To American Forces:

12167	1331	512		4096	1728	343	17576	64	21952		1728	4913	15625	64	10648	1728	5832	4913		729	5832	9261	216	512		
17576	1728	3375	3375		64	9261	9261	1728	15625	512		5832	729	729		4096	1728	343	17576	64	21952					
1728	10648	3375	64	4913	343		5832	4913		19683	-4096	343	64	21952		64	4913	343								
1728	4096	4096	512	343	1728	64	12167	512	3375	21952		125	512	1000	1728	4913		3375	64	4913	343	1728	4913	1000		
5832	6859	512	9261	64	12167	1728	5832	4913	10648	-4913		10648	512	216	13824	9261	1728	4913	1000		12167	1331	512			
64	1728	9261	729	1728	512	3375	343		64	4913	343		12167	1331	512		729	13824	512	3375						
343	512	6859	5832	12167		64	10648		1728	12167	10648		6859	9261	1728	4096	64	9261	21952							
5832	125	2197	512	216	12167	1728	15625	512	-3375																	

THE MIDWAY INVASION FORCE WILL ARRIVE OFF MIDWAY ISLAND ON X-DAY AND IMMEDIATELY BEGIN LANDING OPERATIONS, SECURING THE AIRFIELD AND THE FUEL DEPOT AS ITS PRIMARY OBJECTIVE.

Umpire Sheet - Day 2

1. Imperial Japanese Navy *Kido Butai*

a. Location:	Grid 01036
b. Course:	Northeast
c. Speed:	20 knots
d. Fuel Onboard (each carrier):	1,024,217 gallons / 94%
e. Fuel Used Last 24 Hours	68376 gallons
f. Projected Use Next 24 Hours	Speed * 24 * gallons burned / nm

2. Imperial Japanese Navy Midway Invasion Force

a. Location:	Grid 01037
b. Course:	East
c. Speed:	18 knots

3. USN Task Force 16 (*Enterprise* and *Hornet*)

a. Location:	Grid 01023
b. Course:	West
c. Speed:	15 knots
d. Fuel Onboard (each carrier):	1,448,077.2 gallons / 93%
e. Fuel Used Last 24 Hours	51922.8 gallons
f. Projected Use Next 24 Hours	Speed * 24 * gallons burned / nm
g.	

4. USN Task Force 17 (*Yorktown*)

a. Location:	Grid 01023
b. Course:	Northwest
c. Speed:	20 knots
d. Fuel Onboard (each carrier):	1,317,724.8 gallons / 88%
e. Fuel Used Last 24 Hours	91137.6 gallons
f. Projected Use Next 24 Hours	Speed * 24 * gallons burned / nm

Situation

1. American forces remain undetected.

2. American forces detected a Japanese force, composition unknown, in grid 01045 heading east at approximately 20 knots 24 hours ago.

3. Point totals:

a. Period 3	0 Points
b. Period 5	100 Points
c. Period 6	25 Points

Umpire Sheet - Day 3

1. Imperial Japanese Navy *Kido Butai*

    a. Location: Grid 01037
    b. Course: Various – remaining in 01037
    c. Speed: 20 knots
    d. Fuel Onboard (each carrier): 955,841 gallons / 87%
    e. Fuel Used Last 24 Hours 68,376 gallons
    f. Projected Use Next 24 Hours Speed * 24 * gallons burned / nm

2. Imperial Japanese Navy Midway Invasion Force

    a. Location: Grid 01037
    b. Course: Various – remaining in 01037
    c. Speed: 18 knots

3. USN Task Force 16 (*Enterprise* and *Hornet*)

    a. Location: Grid 01023
    b. Course: Various – remaining in 01023
    c. Speed: 15 knots
    d. Fuel Onboard (each carrier): 1,396,154.4 gallons / 97%
    e. Fuel Used Last 24 Hours 51922.8 gallons
    f. Projected Use Next 24 Hours Speed * 24 * gallons burned / nm
    g.

4. USN Task Force 17 (*Yorktown*)

    a. Location: Grid 01023
    b. Course: Northwest
    c. Speed: 20 knots
    d. Fuel Onboard (each carrier): 1,408,862.4 gallons / 94%
    e. Fuel Used Last 24 Hours 91137.6 gallons
    f. Projected Use Next 24 Hours Speed * 24 * gallons burned / nm

Situation

1. American and Japanese forces remain undetected.

2. Point totals:

a. Period 3	0 Points
b. Period 5	120 Points
c. Period 6	105 Points

Umpire Sheet - Day 4

1. Imperial Japanese Navy *Kido Butai*

   a. Location: Grid 01037
   b. Course: Various – remaining in 01037
   c. Speed: 20 knots
   d. Fuel Onboard (each carrier): 887,465 gallons / 81%
   e. Fuel Used Last 24 Hours 68,376 gallons
   f. Projected Use Next 24 Hours Speed * 24 * gallons burned / nm

2. Imperial Japanese Navy Midway Invasion Force

   a. Location: Grid 01037
   b. Course: Various – remaining in 01037
   c. Speed: 18 knots

3. USN Task Force 16 (*Enterprise* and *Hornet*)

   a. Location: Grid 01023
   b. Course: Various – remaining in 01023
   c. Speed: 15 knots
   d. Fuel Onboard (each carrier): 1,344,231.6 gallons / 90%
   e. Fuel Used Last 24 Hours 51922.8 gallons
   f. Projected Use Next 24 Hours Speed * 24 * gallons burned / nm
   g.

4. USN Task Force 17 (*Yorktown*)

   a. Location: Grid 01023
   b. Course: Northwest
   c. Speed: 20 knots
   d. Fuel Onboard (each carrier): 1,317,724.8 gallons / 88%
   e. Fuel Used Last 24 Hours 91137.6 gallons
   f. Projected Use Next 24 Hours Speed * 24 * gallons burned / nm

Situation

1. Task Forces 16 and 17 detected by *Kido Butai*.

    a. 100 plane (52 torpedo bombers in five squadrons, 48 dive bombers in five squadrons) attacked American forces.
    b. 2 torpedo hits and 1 bomb hit.
    c. *Hornet* sunk.
    d. Points: $25 + 50 + 25 = 100$

2. ***Kido Butai*** detected by Task Force 16, not Task Force 17.

    a. Task Force 16: 72 dive bomber aircraft strike (7 squadrons).
    b. 3 hits.
    c. *Kaga* on fire and burning – destroyed.
    d. Task Force 16 points: $25 + 50 + 25 = 100$

3. Point totals:

    a. Period 3 — 100 Points
    b. Period 5 — 220 Points
    c. Period 6 — 105 Points

Intentions Next 24 Hours: *Kido Butai*

Intelligence Analysis

_____
Date / Time

Enemy force estimated position: _____
Grid Coordinates

Enemy force estimated course / speed: _____

Enemy force estimated intentions:

Launch air strike against: _____

Continue search for our forces: _____

Alter course / speed to: _____

Additional notes: _____

_____

N3 / NAS CO Air Operations Plan (Search)

Number of aircraft to be launched: _____

Mission:

- Search

Search axis (degrees true from home base):

Aircraft 1: _____

Aircraft 2: _____

Aircraft 3: _____

Aircraft 4: _____

Aircraft 5: _____

Range: _____ nm

Objective: _____

N3 / NAS CO Air Operations Plan (Strike)

Umpire will not approve plan without work attached.

Number of aircraft to be launched: _____

Mission:

Objective: _____

Location (bearing and range) of target: _____

Is target within range of strike aircraft? Yes / No

Time of flight to target: _____

Composition of strike force:

- Torpedo bombers: _____
- Dive bombers: _____
- Heavy bombers: _____

N4 Logistics Briefing

Umpire will not approve unless all work is attached.

Number	Name	Max. fuel capacity	Amount used last 24 hours	% used last 24 hours	% remaining onboard	Projected use next 24 hours
Carrier 1						
Carrier 2						
Carrier 3						
Carrier 4						
NAS Fuel Farm						

Tanker Services Required? Yes / No

Intentions Next 24 Hours: *Task Force 16*

Intelligence Analysis

_____
Date / Time

Enemy force estimated position: _____
Grid Coordinates

Enemy force estimated course / speed: _____

Enemy force estimated intentions:

Launch air strike against: _____

Continue search for our forces: _____

Alter course / speed to: _____

Additional notes: _____

_____

N3 / NAS CO Air Operations Plan (Search)

Number of aircraft to be launched: _____

Mission:

- Search

Search axis (degrees true from home base):

Aircraft 1: _____

Aircraft 2: _____

Aircraft 3: _____

Aircraft 4: _____

Aircraft 5: _____

Range: _____ nm

Objective: _____

N3 / NAS CO Air Operations Plan (Strike)

Umpire will not approve plan without work attached.

Number of aircraft to be launched: _____

Mission:

Objective: _____

Location (bearing and range) of target: _____

Is target within range of strike aircraft? Yes / No

Time of flight to target: _____

Composition of strike force:

- Torpedo bombers: _____
- Dive bombers: _____
- Heavy bombers: _____

N4 Logistics Briefing

Umpire will not approve unless all work is attached.

Number	Name	Max. fuel capacity	Amount used last 24 hours	% used last 24 hours	% remaining onboard	Projected use next 24 hours
Carrier 1						
Carrier 2						
Carrier 3						
Carrier 4						
NAS Fuel Farm						

Tanker Services Required? Yes / No

Intentions Next 24 Hours: *Task Force 17*

Intelligence Analysis

_____
Date / Time

Enemy force estimated position: _____
Grid Coordinates

Enemy force estimated course / speed: _____

Enemy force estimated intentions:

Launch air strike against: _____

Continue search for our forces: _____

Alter course / speed to: _____

Additional notes: _____

_____

N3 / NAS CO Air Operations Plan (Search)

Number of aircraft to be launched: _____

Mission:

- Search

Search axis (degrees true from home base):

Aircraft 1: _____

Aircraft 2: _____

Aircraft 3: _____

Aircraft 4: _____

Aircraft 5: _____

Range: _____ nm

Objective: _____

N3 / NAS CO Air Operations Plan (Strike)

Umpire will not approve plan without work attached.

Number of aircraft to be launched: _____

Mission:

Objective: _____

Location (bearing and range) of target: _____

Is target within range of strike aircraft? Yes / No

Time of flight to target: _____

Composition of strike force:

- Torpedo bombers: _____
- Dive bombers: _____
- Heavy bombers: _____

N4 Logistics Briefing

Umpire will not approve unless all work is attached.

Number	Name	Max. fuel capacity	Amount used last 24 hours	% used last 24 hours	% remaining onboard	Projected use next 24 hours
Carrier 1						
Carrier 2						
Carrier 3						
Carrier 4						
NAS Fuel Farm						

Tanker Services Required? Yes / No

Appendix 1 – Glossary

battleship	The largest and most heavily armed type of warship. A battleship's main armament was large caliber guns that could fire explosive shells at very long ranges. U.S.S. *Massachusetts* is a battleship.
bow	1) The forward part of a ship; as in: "Go stand watch on the bow." 2) The foremost outboard part of a ship; as in: "Notice how her bow cuts the water."
combatant	A country fighting in a war.
commander in chief	A senior military officer who commands a very large military organization such as an army or a fleet of ships.
correlation	a relationship that exists between two variables (normally the *x* variable and the *y* variable).
cryptanalysis	The analysis and deciphering of cryptographic writings or systems.
cryptanalyst	A decoder skilled in the analysis of codes.
keel	The central longitudinal structural member of a ship to which all the frames, stem and sternpost are fastened.
port	The left side of a vessel when seen by someone facing the bow.
reconnaissance	an exploratory military search to find an enemy.
starboard	The right side of a vessel when seen by someone facing the bow.

stem	The bow of a ship, referring to the timber between the forward end of the keel and the deck.
stern	The aftermost part of the hull of a ship, referring to the feature between the after end of the keel and the deck.
task force	A group of warships organized under one commander and assigned to perform a specific mission or task.

Appendix 2 – CINCPACFLT Operations Order for Midway Operation[11]

Cincpac file
A16-3/(16)

UNITED STATES PACIFIC FLEET,
PEARL HARBOR, T. H.,
1800, 27 May 1942.

Serial 0114 W.

S E C R E T

REG. NO. 38

Operation Plan
No. 29-42

TASK ORGANIZATION

(a) Striking Forces - Senior striking force commander in MIDWAY Area.

Task Force SIXTEEN - Rear Admiral Spruance

ENTERPRISE, HORNET	2 CV
NORTHAMPTON, VINCENNES, PENSACOLA, MINNEAPOLIS, NEW ORLEANS	5 CA
ATLANTA	1 CL
Desron One, less HULL, McDONOUGH, FARRAGUT, DALE plus CONYNGHAM	1 DL, 5 DD
Desron Six, less CRAVEN, GRIDLEY, McCALL DUNLAP, FUNNING plus GWIN, MONSSEN	1 DL, 5 DD

Task Force SEVENTEEN - Rear Admiral Fletcher

YORKTOWN	1 CV
ASTORIA, PORTLAND	2 CA
Desron Two, less O'BRIEN, WALKE	6 DD

Task Force ELEVEN - Rear Admiral Fitch

SARATOGA	1 CV
CHESTER	1 CA
SAN DIEGO	1 CL
DALE, FANNING, AARON WARD, DUNLAP, CRAVEN, LAFFEY	6 DD

Oilers

PLATTE, CIMARRON	2 AO

(b) Submarine Force, Task Force SEVEN - Captain English

Midway Patrol

DOLPHIN, GATO, CATTLEFISH, GRENADIER, TAMBOR, TROUT, GRAYLING, NAUTILUS, GROUPER, GUDGEON, CACHALOT, FLYING FISH	12 SS

[11] Accessed online 21 Feb 13 at: http://midway1942.org/docs/usn_doc_00.shtml.

Cincpac file
A16-3/(16)
Serial 0114 W.

SECRET

Operation Plan
No. 29-42

(b) (Continued)

Support Patrol

Submarines to be designated about 4 SS

(c) Patrol Wings, Task Force NINE - Rear Admiral Bellinger

Patrol planes and tenders in readiness to be despatched to MIDWAY defense.

(d) Hawaiian Sea Frontier, Task Force FOUR - Rear Admiral Bagley

MIDWAY Local Defenses, Captain Simard

Patrol craft 4 YP, 11 PT
Sixth Marine Defense Battalion reenforced.
Marine Air Group plus aircraft reenforcements from Patrol Wings and Hawaiian Air Force.
Naval Air Station.

JOHNSTON ISLAND

Patrol planes made available for support for MIDWAY.

ISLANDS PATROLS

YPs with aviation gasoline, food and water stationed along island chain at following positions: YP 284 at LISIANSKI; YP 290 at LAYSAN; YP 345 at GARDNER'S PINNACLES; YP 350 at NECKER ISLAND.

(e) Hawaiian Department - Lieutenant General Emmons

Aircraft in readiness to be despatched to MIDWAY defense.

1. Information

(a) The enemy is expected to attempt the capture of MIDWAY in the near future. For this purpose it is

believed that the enemy will employ approximately the following: 2-4 fast BB; 4-5 CV; 8-9 CA; 16-24 DD; 8-12 SS; a landing force with seaplane tenders. The attack on MIDWAY may be preceded or followed by an attack on OAHU. A special intelligence annex is being supplied to Task Force Commanders only. The Commander-in-Chief, U.S. Pacific Fleet will keep Task Force Commanders informed of all pertinent information before and during the operations, including complete weather broadcast.

(b) It is estimated that enemy action against MIDWAY with comprise a full scale attack for its capture and its quick occupation and use against the Hawaiian Area. Operations beginning probably as soon as thirty May, are visualized as follows:

(1) Preliminary reconnaissance by submarines.

(2) Possibly diversionary bombing of positions including OAHU by patrol planes fueled by submarines.

(3) High speed approach by carriers.

(4) Preliminary attacks by carrier aircraft beginning at daylight or during moonlight and continuing for about two days or until defending air forces have been eliminated. It is thought that one or more carriers may take up close in daylight positions for this purpose. It is estimated a northwesterly bearing will be favored. The attack would be designed to be so incessant as to prevent refueling and rearming MIDWAY aircraft. This attempt may be continued by means of bombardment at night.

(5) Covering of attacking carriers against our surface forces by additional carrier groups, and fast battleships.

(6) Landing attack, probably at night, featured by usual attempts at infiltration and extreme resolution on the part of the individual enemy soldier.

(7) Employment of incendiary bombs and possibly gas.

(8) If landing attack is successful, immediate occupation of the island with full base equipment, aircraft, KTBs, etc.

(9) Covering with concentrations of submarines designed to intercept our supporting surface forces both in the MIDWAY area and on some such line as about two hundred miles west of OAHU.

(10) It is probable that if our carriers are sighted early in the operations, they will become the primary object of the enemy carriers.

(c) Task Force ELEVEN will be ready to depart from West Coast ports on five June, and will be directed to arrive in the Hawaiian Area as soon as possible. The availability of Task Force SEVENTEEN as a unit is dependent of the condition of the YORKTOWN. If YORKTOWN is not available, instructions will be issued as to employment of remainder of force. GWIN and MUSTIN are now engaged in escorting between PEARL and MIDWAY and will join their Task Forces when released.

(d) Task Force EIGHT composed of 2 CA, 3 CL, 4 DD from the Fleet plus certain forces normally under the Commander Northwestern Sea Frontier and certain Army ALASKAN Air Forces are operating in the North Pacific Area against an expected attack in the ALEUTIANS.

(d) The defenses at MIDWAY have recently been reenforced to the totals indicated:

Aircraft

Reenforcement	Total
16 VP; 7 VF; 18 VSB	16 VP; 27 VF; 36 VSB

Armament

Reenforcement	Total
4 - 60mm Mortar;	8 - 60mm Mortar
8 - 37mm AA;	8 - 37mm AA
12 - 3" AA;	24 - 3" AA
	4 - 3", 4 - 7", 6 - 5".

Troops

Reenforcement of 670 men bringing the total, including air personnel, to:

	Officers	Enlisted
6th Defense Battalion	52	1357
3d Defense Battalion	13	379
Raider Companies	9	269
Marine Air Squadron	45	470
Naval Air Squadron	22	372
Net Depot		12
Cable Station		25
Pan American Air		2
Total	141	2886

(f) Additional communication and air operations personnel are being made available to the Commanding Officer, MIDWAY.

(g) Some of the initial dispositions such as that of the submarines have been directed by separate directives but are being repeated herein in order to make this plan of operations complete

(h) This Plan deals primarily with the expected attack on MIDWAY - but the deployment herein made is also believed to promote the security of OAHU.

2. These forces will hold MIDWAY and will inflict maximum damage on the enemy by strong attrition tactics.

3. (a) Striking Forces.

(1) Inflict maximum damage on enemy by employing strong attrition tactics. Do not accept such decisive action as would be likely to incur heavy losses in our carriers and cruisers. A letter of instructions is being furnished separately to striking force commanders.

(2) Operate with Task Forces available initially to the northeast of MIDWAY commencing thirty May, in order to seize opportunity to obtain initial advantage against carriers which are employing their air groups against MIDWAY.

(3) Initially establish air search in the northwest sector from MIDWAY to eastward of bearing twenty degrees true from that place.

(4) Task Force SIXTEEN depart PEARL on twenty-eight May; other forces join Task Force SIXTEEN as directed by Commander-in-Chief, U.S. Pacific Fleet.

(5) Oilers depart in company with Task Force SIXTEEN and operate as directed by Senior Striking Force Commander in area of operations.

(b) Submarine Force.

(1) Inflict maximum damage to enemy. Priority of targets - carriers, battleships, transports, cruisers, auxiliaries.

MIDWAY Patrol

(2) As soon as available, submarines take stations as shown on diagram in Annex "A".

(3) When information is received proceed to attack objectives without regard for area assignment.

(4) Transmit such information as does not interfere with primary task of attack.

Support Patrol

(5) Take stations on patrol line 045°-225° with center at Latitude 30-00 N, Long. 169-30 W, distance thirty miles.

(6) Support striking forces which may be forced to retire over patrol line.

(c) Patrol Wings.

(1) Despatch patrol planes to MIDWAY and JOHNSTON as may be directed; to operate under Commanding Officers of Air Stations of those places.

(2) Station patrol tender at FRENCH FRIGATE SHOAL.

(d) Hawaiian Sea Frontier.

MIDWAY Local Defenses.

(1) Hold MIDWAY.

(2) Aircraft obtain and report early information of enemy advance by searches to maximum practicable radius from MIDWAY covering daily the greatest arc possible whit a number of planes available between true bearing from MIDWAY clockwise two hundred degrees dash twenty degrees. Inflict maximum damage on enemy, particularly carriers, battleships and transports.

(3) Take every precaution against being destroyed on the ground or water. Long range aircraft retire to OAHU when necessary to avoid such destruction. Patrol planes fuel from AVD at FRENCH FRIGATE SHOAL if necessary.

(4) Patrol craft patrol approaches; exploit favorable opportunities to attack carriers, battleships, transports and auxiliaries. Observe KURE and PEARL and HERMES REEF. Give prompt warning of approaching enemy forces.

(5) Keep Commander-in-Chief, U.S. Pacific Fleet and Commander Hawaiian Sea Frontier fully informed of of air searches and other air operations; also of weather encountered by search planes.

Johnston Island

Maintain daily searches with patrol planes in sector with median 295°.

Island Patrols

Supply gasoline and other assistance to aircraft as may be required.

(c) Hawaiian Department.

(1) Provide, as directed, a striking force of long range bombers and torpedo carrying aircraft to operate under Commanding Officer, MIDWAY.

(2) Hold special long range bombers in readiness at OAHU-KAUAI Area to strike enemy forces attacking MIDWAY.

(x)(1) Enemy submarines are not important objectives and their identification must be positive before they are attacked. Do not attack submarines in the areas shown in Annex "A".

(2) Recognition of own forces is vital. As one precaution against attack on our striking forces by own air forces, Commander-in-Chief, U.S. Pacific Fleet will inform Task Force Commanders of all air attacks ordered for shore-based aircraft.

(3) Insure that contact reports are accurate, complete and prompt.

(4) This Operation Plan effective 1830 GCT twenty-eight May.

4. Gasoline for aircraft and limited fuel for CAs and smaller vessels available at MIDWAY. One AVD at FRENCH FRIGATE SHOAL. Fuel oil at PEARL and in attached oilers.

3. (a) Communications according to PAC SEVENTY except as follows:

Radio Frequency Plans

Task Forces ELEVEN, SIXTEEN, and SEVENTEEN use radio frequency plan four.
Oilers guard 4205 Kcs. series.
Task Forces SEVEN and Patrol Planes based MIDWAY and JOHNSTON guard 4265 kcs. from 0730 to 1830 GCT; 12795 kcs. 1830 to 0730 GCT, primary; 4385 kcs 0730 to 1830 GCT; and 13155 kcs. 1830 to 0730 GCT, secondary.
Army aircraft assigned defense MIDWAY use 4265 primary, 4385 secondary without shift to higher harmonics. Naval Air Station MIDWAY must guard this.
MIDWAY local defense as assigned by Commander.
All Units: In view of known Japanese practice of jamming radio frequencies calibrate transmitters and receivers for secondary frequencies. The use of NPM primary Fox is available for relay through NPM or Commander-in-Chief, U.S. Pacific Fleet, who guards 4205 kcs. series primary and 4295 ksc. series secondary.

Authentication

The Japanese are adopt at the practice of deception. Have authenticators ready for use when needed. Small craft and aircraft except patrol planes use two alternate letters from the expression:

"Farmer in the dell"

EXAMPLE: RE or EL or NH

Cincpac file
A16-3/(16)
Serial 0114 W.

SECRET

Operation Plan
No. 29-42

Use of CABLE to MIDWAY

Commander-in-Chief, U.S. Pacific Fleet, Radio NPM, MIDWAY are connected by cable. Use of plain language over the cable is authorized when speed is essential. Commandant, Fourteenth Naval District and Naval Air Station MIDWAY place U.S. Naval personnel at terminals to supervise operation, and at MIDWAY to communicate with Naval Air Station operational center.

Cryptographic Aids.

Naval Air Station MIDWAY, JOHNSTON, and PALMYRA hold following crypto-channels: 104, 105, 106, 107, 135, 135, 143, 144, 145, 171, 176, 180, and 184.

(b) Use chart 4000-Y extended westward to Longitude column 01.

(c) Commander-in-Chief, U.S. Pacific Fleet at Submarine Base, PEARL HARBOR, will coordinate operations of forces assigned in this Plan for the defense of MIDWAY.

C. W. NIMITZ,
Admiral,
Commander-in-Chief

Annexes:

A - Diagram of MIDWAY Submarine Positions.
B - Special Intelligence Annex.

Cincpac file
A16-3/(16)
Serial 0114 W.

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Operation Plan
No. 29-42

DISTRIBUTION

Method	Address	No.	Reg. Nos.
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(a)	Comtaskfor 11 for distribution	11	40-50 incl.
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(b)	CIMARRON	1	52
(b)	Comtaskfor 7	2	53,54
(b)	Comtaskfor 9 (plus 30 copies Annex "A")	2	55,56
(b)	Comtaskfor 4, (2 for delivery to MIDWAY Local Defenses)	4	57-60 incl.
(b)	ComGen. Haw.Dept (plus 30 copies Annex "A")	2	61,62
File		3	63,64,65
Reserve		20	66-85 incl.
(a)	CO JOHNSTON (a) Clipper lock box air mail. (b) Officer messenger.	1	86

NOTE: Annex "B" furnished Task Force Commanders only, i.e., with copies nos.7, 29, 40, 53, 55, 57 & 61.

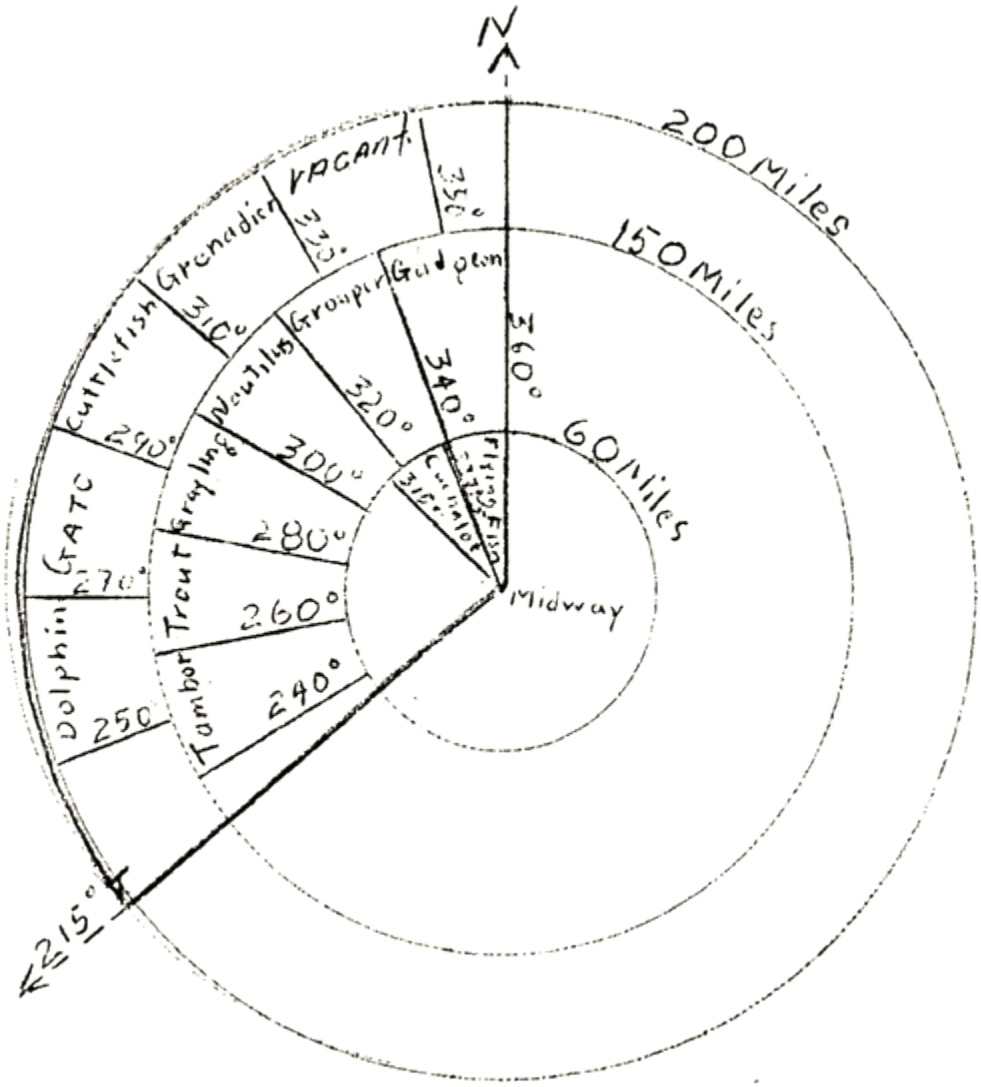
P. C. CROSLEY,
Flag Secretary.

THIS PLAN MUST NOT FALL INTO THE HANDS

OF THE ENEMY

ANNEX "A" TO SINCPAC OPERATION PLAN NO. 29-42.

Initial Submarine Patrol Areas.



Note #1. Submarines underlined in red are on station from daylight May 26, 1942. Other stations will be taken as soon as the submarines become available.

Note #2. In the area outlined in blue aircraft approach and bombing of submarines is forbidden. (See Operation Plan No. 29-42, para. 3(b)).

SECRET

PLAN FOR OILERS

1. CIMARRON and PLATTE are accompanying Task Force Sixteen. On completion of fueling northeast of MIDWAY about 31 May they will be released. They will then retire with their destroyer escorts to the southeast and carry out the following plan:

(a) Pass through Point A in company at 0300 GCT two June.

(b) (1) CIMARRON proceed through points B, C, D, B in that order, arriving at B at 2000 GCT two June, four June and every second day thereafter.

(2) PLATTE proceed along the line AD and join Task Force SEVENTEEN as may be directed by Commander Task Force SEVENTEEN. If no randezvous is made, proceed ariund the same circuit DBC arriving at B at 2000 GCT on add days of the month. If PLATTE is utilized by Task Force SEVENTEEN, proceed thereafter to the BCD area and adjust position and speed to proceed around the circuit, arriving at B at 2000 GCT on odd days of the month.

2. Points: A - 31° N, 167° W.

B - 28° N, 167° W.

C - 26° N, 163° W.

D - 29° N, 163° W.

M. F DRAEMEL,
Chief of Staff.

DISTRIBUTION:
Comtaskfor 17
Comtaskfor 11
Comtaskfor 7 (12)
Comtaskfor 9 (5)

P. C. CROSLEY,
Flag Secretary.

Cincpac File No.

UNITED STATES PACIFIC FLEET
U. S. S. PENNSYLVANIA, Flaghip
FLAGSHIP OF THE COMMANDER-IN-CHIEF

SECRET

APPENDIX "2" TO SINCPAC OPERATION PLAN 29-42

INITIAL AREAS FOR STRIKING FORCES

1. Task Force SIXTEEN initially operate north of latitude 32° and west of longitude 173° W.

2. Task Force SEVENTEEN initially operate north of latitude 32° and east of longitude 173° W.

3. Both task forces during each local forenoon approach Point "Luck" (Lat. 32 N, Long. 173 W) and exchange communications by plane if desired.

4. The above is not intended to restrict the operation of either force in any manner but to avoid having embarrassing or premature contact made with own forces.

M. F. DRAEMEL,
Chief of Staff.

DISTRIBUTION:
Comtaskfor 17 (1)
Comtaskfor 11 (1)
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Comtaskfor 9 (1)
Comtaskfor 16 (by despatch)

P. C. CROSLEY,
Flag Secretary.

Appendix 3 – Admiral Nimitz' Letter to His Commanders, 28 May 1942[12]

Cincpac File No.

UNITED STATES PACIFIC FLEET
U. S. S. PENNSYLVANIA, Flagship
FLAGSHIP OF THE COMMANDER-IN-CHIEF

A16-3/A4-3/
FF12(12)/(16)

Serial 0114 W.

May 28, 1942.

S E C R E T

From: Commander-in-Chief, United States Pacific Fleet.
To: Commander Striking Forces (Operation Plan 29-42).

Subject: Letter of Instructions.

1. In carrying out the task assigned in Operation Plan 29-42 you will be governed by the principle of calculated risk, which you shall interpret to mean the avoidance of expo-sure of your force to attack by superior enemy forces without good prospect of inflicting, as a result of such exposure, greater damage to the enemy. This applies to a landing phase as well as during preliminary air attacks.

C. W. NIMITZ.

Copy to:
Cominch.
ComTaskFor. 16. (Delivered by hand by War Plans)
ComTaskFor. 17. (Delivered by hand by War Plans)
ComTaskFor. 11. (Hold until arrival Pearl)

P. C. CROSLEY,
Flag Secretary.

[12] Accessed online 21 Feb 13 at: http://midway1942.org/docs/usn_doc_24.shtml.

Appendix 4 – Background Movie Questions

Name: _____

"Tora, Tora, Tora" – Questions 2

1. Commander Fuchida, who will lead the strike on Pearl Harbor is disappointed because what priority targets are missing from Pearl Harbor?

_____

2. What is Colonel Bratton, the intelligence officer, convinced the Japanese will do on Sunday, November 30th, 1941?

_____

3. To whom does the President send a personal message just before the attack?

_____

4. What does Lieutenant Commander Kramer's wife get him to eat when the two of them are driving around Washington on the night before the attack?

_____

5. On the morning of the attack, what is General Marshal, the Army Chief of Staff, doing?

_____

6. On the morning of the attack, what does a U.S. destroyer see when patrolling at the entrance to Pearl Harbor?

_____

7. On the morning of the attack, two U.S. Army radar operators spot the Japanese strike force on radar coming in. What does the officer at the command center think it is that the radar operators see?

_____

8. Just as the attack occurs, what message does Commander Fuchida send to his Admiral?

_____

9. Just as the attack occurs, what message does an American naval officer send to all commands?

_____

10. What U.S. battleship blows up under the attack?

_____

11. Why are Commander Genda and Commander Fuchida angry at the conclusion of the attack?

_____

12. At the conclusion of the movie, Admiral Yamamoto states that he fears the Japanese have awakened a sleeping giant and filled him with a terrible resolve. Who is the sleeping giant?

_____

Name: _____

"Tora, Tora, Tora" – Questions 2

1. Commander Fuchida, who will lead the strike on Pearl Harbor is disappointed because what priority targets are missing from Pearl Harbor?

   Ans: The American aircraft carriers.

   _____

2. What is Colonel Bratton, the intelligence officer, convinced the Japanese will do on Sunday, November 30th, 1941?

   Ans: Attack the United States.

   _____

3. To whom does the President send a personal message just before the attack?

   Ans: The Emperor of Japan.

   _____

4. What does Lieutenant Commander Kramer's wife get him to eat when the two of them are driving around Washington on the night before the attack?

   Ans: A hot dog and a Coke.

   _____

5. On the morning of the attack, what is General Marshal, the Army Chief of Staff, doing?

   Ans: Riding his horse.

   _____

6. On the morning of the attack, what does a U.S. destroyer see when patrolling at the entrance to Pearl Harbor?

   Ans: A submarine.

---

7. On the morning of the attack, two U.S. Army radar operators spot the Japanese strike force on radar coming in. What does the officer at the command center think it is that the radar operators see?

   Ans: A flight of B-17's flying in from the United States.

---

8. Just as the attack occurs, what message does Commander Fuchida send to his Admiral?

   Ans: "Tora, Tora, Tora."

---

9. Just as the attack occurs, what message does an American naval officer send to all commands?

   Ans: "Air raid, Pearl Harbor. This is no drill."

---

10. What U.S. battleship blows up under the attack?

    Ans: U.S.S. Arizona.

---

11. Why are Commander Genda and Commander Fuchida angry at the conclusion of the attack?

Ans: Admiral Nagumo refuses to launch a second strike.

---

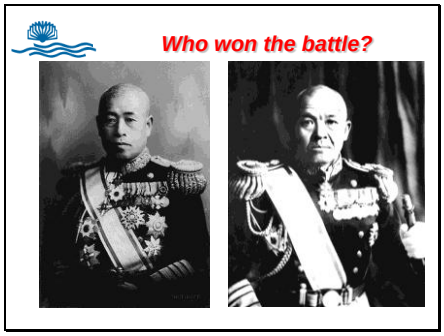
12. At the conclusion of the movie, Admiral Yamamoto states that he fears the Japanese have awakened a sleeping giant and filled him with a terrible resolve. Who is the sleeping giant?

Ans: The United States.

Appendix 5 – Classroom Slide Handouts

Slide 1

Slide 2



Slide 3

Slide 4

Who won the battle?

Captain Joseph Rochefort, USN

Officer in Charge, Joint Intelligence Center, Pacific

Leader of the cryptologists who broke into the Imperial Japanese Navy's operations code and discovered that the Japanese planned to attack Midway Island.

Since Julius Caesar's day over 2000 years ago, armies and navies have used codes to protect important messages.

http://illuminations.nctm.org/ActivityDetail.aspx?id=5

Cryptologists have come up with ever more ingenious ways to crack those codes.

Slide 5

Look at this message...

20-15-4-1-25 25-15-21 23-9-12-12 1-20-20-1-3-11 13-9-4-23-1-25 9-19-12-1-14-4

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

20-15-4-1-25 25-15-21 23-9-12-12 1-20-20-1-3-11 13-9-4-23-1-25 9-19-12-1-14-4

T-O-D-A-Y Y-O-U W-I-L-L A-T-T-A-C-K M-I-D-W-A-Y I-S-L-A-N-D

Slide 6

Now look at this one...

upebz xf xjmm buubdl njexbz jtmboe

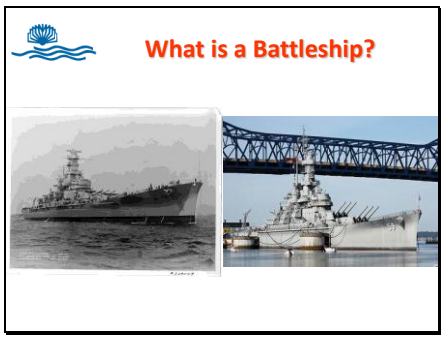
today we will attack midway island

Match the corresponding letters. What pattern do you see?

Each letter is "shifted" one position to the right (t becomes u, o becomes p, etc.)

You can "shift" as many postions as you like up to what number?

Slide 7



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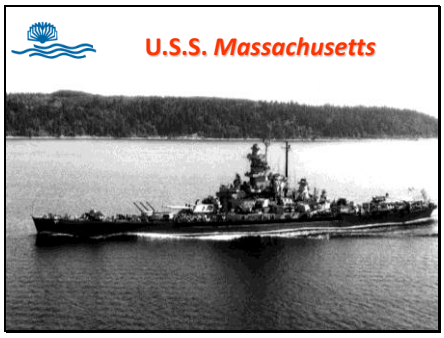

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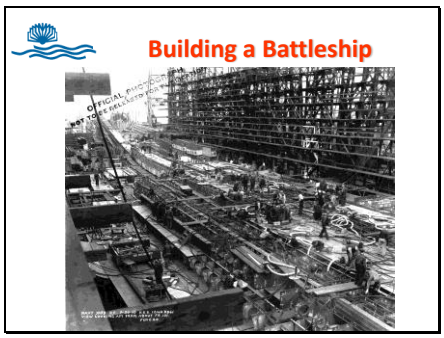

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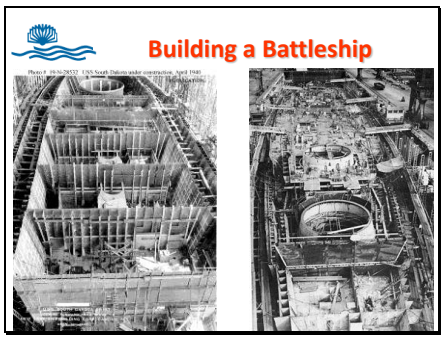

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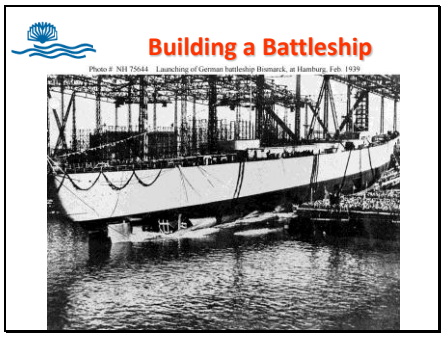

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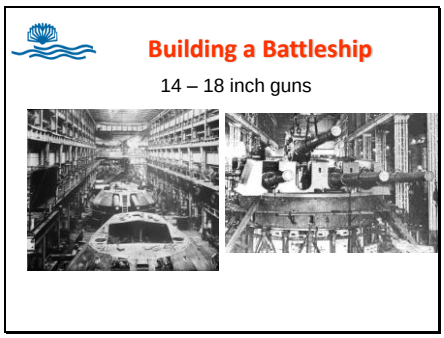
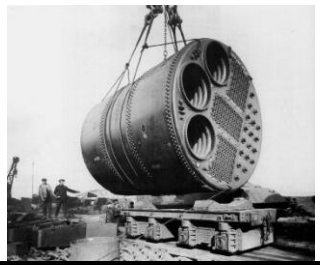


Slide 13

Building a Battleship



Slide 14

How Much Did One Cost?

- Hull, machinery, habitability, armament, armor
- $100,000,000 or $9,320,000,000 in today's dollars (an aircraft carrier costs approximately $6,200,000,000 to build).

Slide 15

Staying Power

- A function of how well a ship can resist harm from attack by bombs, shells, or torpedoes.
- Variables include:
  - How much armor does the ship have – above and below the waterline?
  - How fast is the ship? – with more speed, it can better evade bombs, shells, and torpedoes.

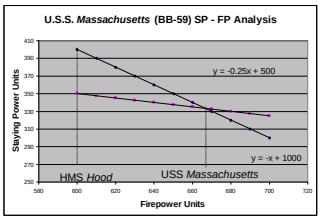
Slide 16

Firepower

- A function of how well a ship can inflict damage on another.
- Variables include:
  - Number and size of weapons such as guns or torpedoes.
  - Accuracy of weapons.
  - Speed of the ship – its ability to maneuver so as to inflict damage on the enemy while evading the enemy's weapons.

Slide 17

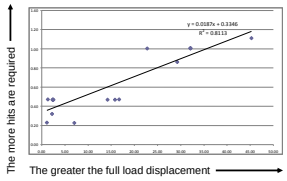
SP vs. FP



Slide 18

Testing the Hypothesis

The greater the full load displacement of a ship (a measure of how big the ship is) the more shells, bombs, or torpedoes it takes to put her out of action.



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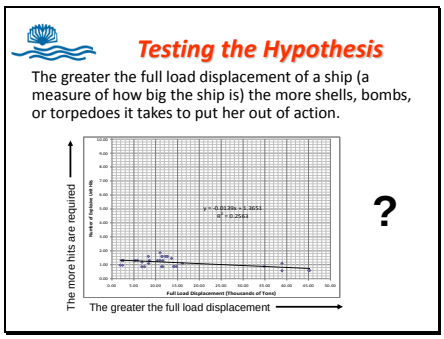

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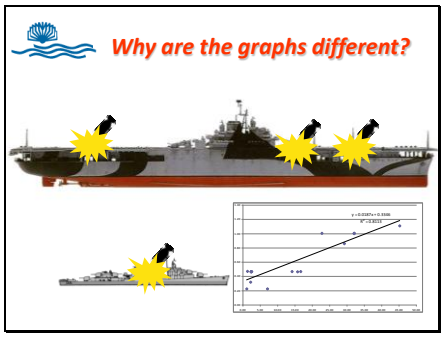

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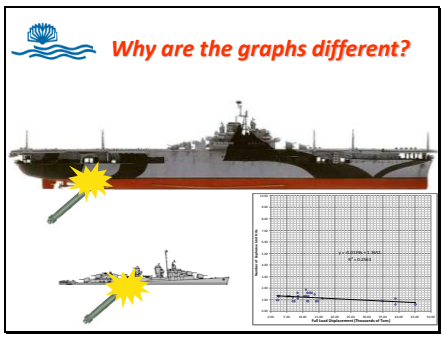
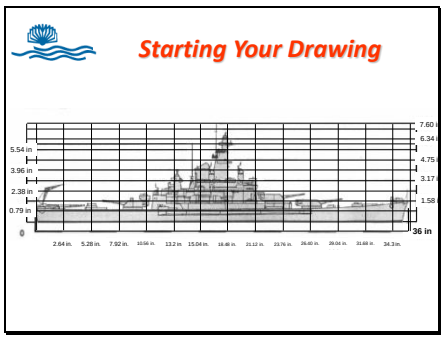


Slide 22



Name: _____

9th Grade Final Project - End of Project Reflection

1. The project was designed to help you develop the following skills:

   a. **Responsibility** - being responsible for getting all work done.

   b. **Self-confidence** - having the confidence that you will get work done.

   c. **Time management** - being responsible for getting work done on time.

   d. **Resiliency** - sticking with a problem until you solve it.

   e. **Team work** - working together without cheating to get work done.

   f. **Leadership** - inspiring people and being responsible for their actions.

   g. **Mathematical computation -** finding answers to complex problems.

   h. **Mathematical reasoning -** discovering how to set up a mathematical means to solve a complex problem.

   Circle two skills that you believe you developed the most fully during the project.

   For each skill, give one example of a piece of work that demonstrates that you developed that skill.

   _____

   _____

   _____

   _____

   _____

   _____

_____

_____

_____

2. It is very easy to become frustrated when completing a task seems impossible.

   a. Provide one example of a task upon which you became frustrated and describe how you overcame that frustration.

_____

_____

_____

_____

_____

   b. Provide one example of how you helped another student overcome his / her frustration and complete a task. How did you help that student?

_____

_____

_____

_____

_____

3. The following is a list of all the project tasks. Circle the one you are most proud of:

Breaking the Code	**Staying Power / Firepower System of Equations**
16 inch Gun Data Analysis	**Ship Stability Problems**
***Massachusetts* Scale Drawing**	***Massachusetts* Scale Model**
Maneuvering Board Exercise	**Comm. Signal Exercise**
War Game Map	**War Game**

Describe why you are proud of this work:

_____

_____

_____

_____

_____

4. If you could do one task over again because you are not happy with the outcome, which would it be?

Breaking the Code	**Staying Power / Firepower System of Equations**
16 inch Gun Data Analysis	**Ship Stability Problems**
***Massachusetts* Scale Drawing**	***Massachusetts* Scale Model**
Maneuvering Board Exercise	**Comm. Signal Exercise**
War Game Map	**War Game**

Why would you want to do this over again?

_____

_____

_____

_____

_____

5. Describe what you enjoyed most during the final project this trimester.

_____

_____

_____

_____

_____

6. Describe what you liked least during the final project this trimester.

_____

_____

_____

_____

_____

Name: _____

Date: _____

Advisor: _____

Geometry – Developing Similar Shapes Review

1. **Geometry of the Ship Unit.** A shipping container has the following dimensions:

$$20' \times 8' \times 8'$$

You wish to construct a model whose length is on greater than 0.2 feet.

a. What is the scale factor you will need to apply to the dimensions of the actual shipping container to find the dimensions of your model?

Scale factor is: _____

b. What are the dimensions of the model container box?

Dimensions: _____

2. **Geometry of the Ship Unit.** You wish to construct a model of a battleship which has the following dimensions:

Length overall:	680 ft., 9.813 in.
Maximum beam:	108 ft., 2.250 in.
Maximum draft:	36 ft., 9.000 in.

a. If you want your model's length overall to be no more than 36 inches (3 feet), what scale factor will you need to apply to the actual ship dimensions to find the dimensions of your model?

Scale factor is: _____

b. What are the dimensions of the model battleship?

Length overall: _____

Maximum beam: _____

Maximum draft: _____

3. **Navigation Unit.** The distance from the island of O'ahu in Hawai'i to the island of Midway in the Central Pacific Ocean is 1300 nautical miles. On a game board, the distance is 13 feet. What is the scale factor used in the chart (***remember to convert nautical miles to yards and yards to feet or vice versa***).

Scale factor is: _____

4. **Congruence and Similarity Unit.** You wish to construct a model of the Solar System that is no greater than 25 feet in length with the Sun at one end and Pluto at the other. Complete the following table to determine the distances of each model planet from the model Sun:

Body	Planet Distance from Sun (km)	Scale Factor	Model Distance (m)
Sun			
Mercury	57,950,000		
Venus	108,110,000		
Earth	149,570,000		
Mars	227,840,000		
Jupiter	778,140,000		
Saturn	1,427,000,000		
Uranus	2,870,300,000		
Neptune	4,499,900,000		
Pluto	5,913,000,000		

Name: _____

Date: _____

Advisor: _____

Geometry – Developing Similar Shapes Review

1. **Geometry of the Ship Unit.** A shipping container has the following dimensions:

$$20' \times 8' \times 8'$$

You wish to construct a model whose length is on greater than 0.2 feet.

a. What is the scale factor you will need to apply to the dimensions of the actual shipping container to find the dimensions of your model?

Scale factor is: **0.01**

b. What are the dimensions of the model container box?

Dimensions: $(\mathbf{20'} * \mathbf{0.01}) \times (\mathbf{8'} * \mathbf{0.01}) \times (\mathbf{8'} * \mathbf{0.01}) = \mathbf{0.2'} \times \mathbf{0.08'} \times \mathbf{0.08'}$

2. **Geometry of the Ship Unit.** You wish to construct a model of a battleship which has the following dimensions:

Length overall:	680 ft., 9.813 in.
Maximum beam:	108 ft., 2.250 in.
Maximum draft:	36 ft., 9.000 in.

a. If you want your model's length overall to be no more than 36 inches (3 feet), what scale factor will you need to apply to the actual ship dimensions to find the dimensions of your model (**remember to convert feet to inches or inches to feet)**?

Scale factor is: **0.0044**

b. What are the dimensions of the model battleship?

Length overall: **36 inches**

Maximum beam: **5.71 inches**

Maximum draft: **1.94**

3. **Navigation Unit.** The distance from the island of O'ahu in Hawai'i to the island of Midway in the Central Pacific Ocean is 1300 nautical miles. On a game board, the distance is 13 feet. What is the scale factor used in the chart (***remember to convert nautical miles to yards and yards to feet or vice versa***).

Scale factor is: $\mathbf{1.67 \times 10^{-6}}$

4. **Congruence and Similarity Unit.** You wish to construct a model of the Solar System that is no greater than 25 feet in length with the Sun at one end and Pluto at the other. Complete the following table to determine the distances of each model planet from the model Sun:

Body	Planet Distance from Sun (km)	Scale Factor	Model Distance (m)
Sun			
Mercury	57,950,000	0.000000004227972	0.25
Venus	108,110,000	0.000000004227972	0.46
Earth	149,570,000	0.000000004227972	0.63
Mars	227,840,000	0.000000004227972	0.96
Jupiter	778,140,000	0.000000004227972	3.29
Saturn	1,427,000,000	0.000000004227972	6.03
Uranus	2,870,300,000	0.000000004227972	12.14
Neptune	4,499,900,000	0.000000004227972	19.03
Pluto	5,913,000,000	0.000000004227972	25

Preliminary Instruction: Vector Analysis: Maneuvering Board

Slide 1

Geometry – Vector Analysis

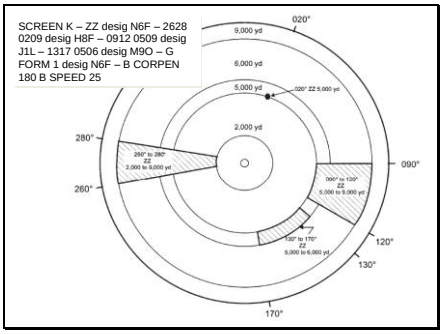
Using Maneuvering Boards
2012 – 2013 School Year

Slide 2

Slide 3

Slide 4

Slide 5



Slide 6

Basic Vector Definitions

A vector is a quantity that has both magnitude and direction. The magnitude is a scalar quantity, a scalar being defined as a quantity which may be completely specified by a number and perhaps a unit. Common textbook representations of vectors include boldfaced letters and boldface with an arrow above them. For example a displacement vector of 30 meters east could be represented in a variety of ways:

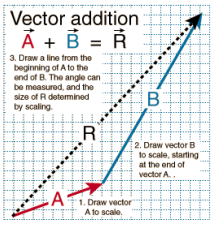
$\mathbf{D}$ $\vec{\mathbf{D}}$ or a graphical representation 30 m

The magnitude of the vector might be represented by absolute value signs around the vector symbol, or just the letter without the boldface.

magnitude of $\vec{\mathbf{D}} = |\vec{\mathbf{D}}| = D = 30$ meters

A vector might also be expressed in terms of unit vectors.

Slide 7

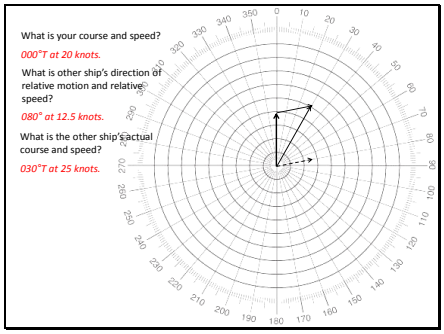


Slide 8

Ralston (3 – minute) Rule Practice

Distance Traveled	Time	Speed in Knots
1000 yards	3 minutes	
3560 yards	3 minutes	
4423 yards	3 minutes	
1200 yards	3 minutes	
5000 yards	6 minutes	
1520 yards	9 minutes	
2000 yards	4 minutes	
8000 yards	12 minutes	
1500 yards	5 minutes	
7500 yards	10 minutes	
15000 yards	18 minutes	
3000 yards	4.5 minutes	
3000 yards	3.3 minutes	
1050 yards	1 minute	
1590 yards	2 minutes	

Slide 9



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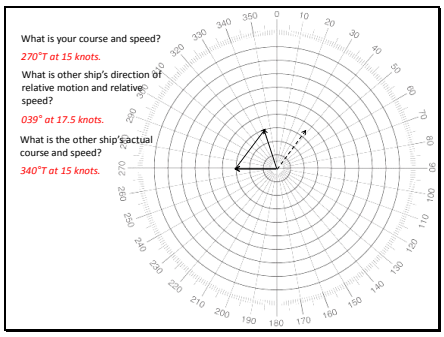

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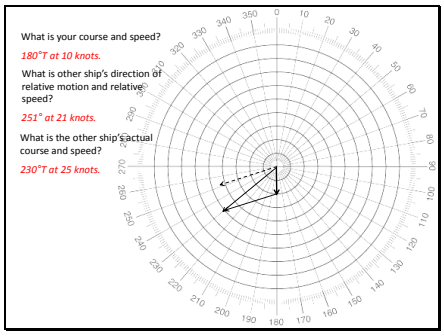

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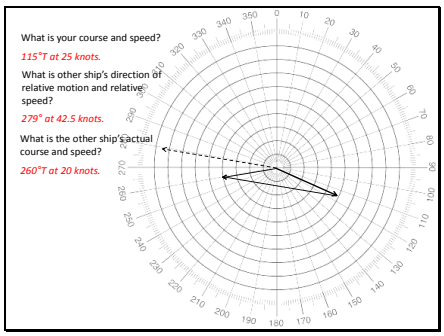
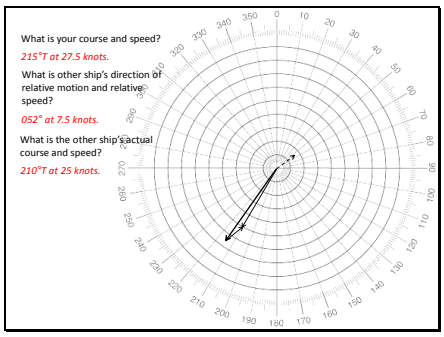
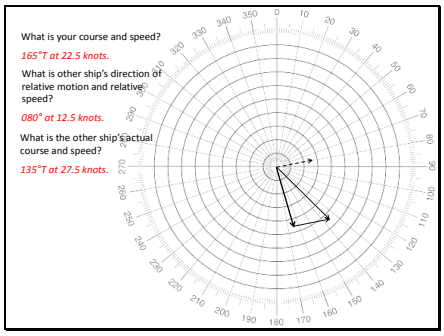


Slide 13



Slide 14



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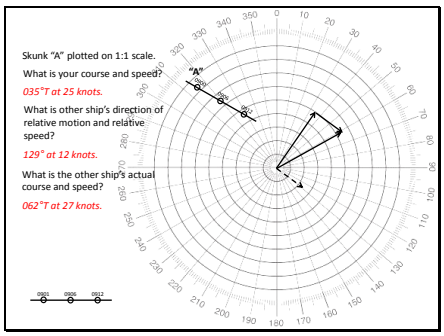
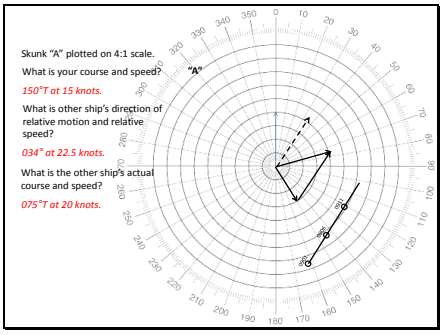


Slide 16



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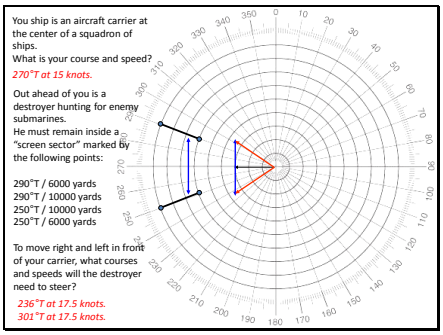

Name:_____

Maneuvering Board Problem Set 1

1. Use a maneuvering board, ruler, and dividers to answer the following questions:

Problem 1:

a. Plot a vector to depict own-ship course of 050°T at 15 knots.

b. Plot a relative motion vector for the other ship of 150° at 10 knots.

c. What is the other ship's actual course and speed?

_____°T at _____ knots 088°T, 17.5 knots

Problem 2:

a. Plot a vector to depict own-ship course of 235°T at 10 knots.

b. Plot a relative motion vector for the other ship of 165° at 15 knots.

c. What is the other ship's actual course and speed?

_____°T at _____ knots 192°, 21 knots

Problem 3:

a. Plot a vector to depict own-ship course of 320°T at 20 knots.

b. Plot a relative motion vector for the other ship of 120° at 5 knots.

c. What is the other ship's actual course and speed?

_____°T at _____ knots 325°T, 15 knots

Problem 4:

a. Plot a vector to depict own-ship course of 135°T at 20 knots.

b. Plot a true course and speed vector for the other ship of 180° at 15 knots.

c. What direction of relative motion and relative speed of the other ship?

_____°T at _____ knots 267°T, 14.5 knots

Problem 5:

a. Plot a vector to depict own-ship course of 020°T at 20 knots.

b. Plot a true course and speed vector for the other ship of 180° at 25 knots.

c. What direction of relative motion and relative speed of the other ship?

_____°T at _____ knots 189°T, 44 knots

Problem 6:

a. Plot a vector to depict own-ship course of 230°T at 5 knots.

b. Plot a true course and speed vector for the other ship of 340° at 5 knots.

c. What direction of relative motion and relative speed of the other ship?

_____°T at _____ knots 016°T, 8 knots

2. Find the speed in knots using the Ralston (3-minute) Rule:

Distance Traveled	Time	Speed in Knots
2300 yards	3 minutes	23
1850 yards	3 minutes	18.5
5423 yards	3 minutes	54.23
3631 yards	3 minutes	36.31
1250 yards	6 minutes	6.25
860 yards	9 minutes	2.87
907 yards	4 minutes	6.8
4567 yards	12 minutes	11.42
888 yards	5 minutes	5.33
1267 yards	10 minutes	3.81
15000 yards	36 minutes	12.5
3000 yards	10.5 minutes	8.57
3000 yards	8 minutes	11.25
1050 yards	2 minutes	15.75
1590 yards	1 minute	47.70

Name:_____

Maneuvering Board Problem Set 1

1. Use a maneuvering board, ruler, and dividers to answer the following questions:

Problem 1:

a. Plot a vector to depict own-ship course of 050°T at 15 knots.

b. Plot a relative motion vector for the other ship of 150° at 10 knots.

c. What is the other ship's actual course and speed?

_____°T at _____ knots

Problem 2:

d. Plot a vector to depict own-ship course of 235°T at 10 knots.

e. Plot a relative motion vector for the other ship of 165° at 15 knots.

f. What is the other ship's actual course and speed?

_____°T at _____ knots

Problem 3:

a. Plot a vector to depict own-ship course of 320°T at 20 knots.

b. Plot a relative motion vector for the other ship of 120° at 5 knots.

c. What is the other ship's actual course and speed?

_____°T at _____ knots

Problem 4:

a. Plot a vector to depict own-ship course of 135°T at 20 knots.

b. Plot a true course and speed vector for the other ship of 180° at 15 knots.

c. What direction of relative motion and relative speed of the other ship?

_____°T at _____ knots

Problem 5:

a. Plot a vector to depict own-ship course of 020°T at 20 knots.

b. Plot a true course and speed vector for the other ship of 180° at 25 knots.

c. What direction of relative motion and relative speed of the other ship?

_____°T at _____ knots

Problem 6:

a. Plot a vector to depict own-ship course of 230°T at 5 knots.

b. Plot a true course and speed vector for the other ship of 340° at 5 knots.

c. What direction of relative motion and relative speed of the other ship?

_____°T at _____ knots

2. Find the speed in knots using the Ralston (3-minute) Rule:

Distance Traveled	Time	Speed in Knots
2300 yards	3 minutes	
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5423 yards	3 minutes	
3631 yards	3 minutes	
1250 yards	6 minutes	
860 yards	9 minutes	
907 yards	4 minutes	
4567 yards	12 minutes	
888 yards	5 minutes	
1267 yards	10 minutes	
15000 yards	36 minutes	
3000 yards	10.5 minutes	
3000 yards	8 minutes	
1050 yards	2 minutes	
1590 yards	1 minute	

Name:_____

Maneuvering Board Problem Set 2

1. Use a maneuvering board, ruler, and dividers to answer the following questions:

   a. On radar, you note the following bearings and ranges for Skunk "A":

Time	Bearing	Range
0900	330°T	7000 yards
0903	336°T	6200 yards
0906	343°T	5500 yards

   Your course and speed is 000°T at 20 knots.

   Skunk "A"'s direction of relative motion and relative speed is:

   _____°T at _____ knots 113°T at 10 knots

   Skunk "A"'s course and speed is:

   _____°T at _____ knots 029°T at 18 knots

   b. On radar, you note the following bearings and ranges for Skunk "B":

Time	Bearing	Range
0915	270°T	4000 yards
0918	232°T	4000 yards
0921	207°T	5450 yards

   Your course and speed is 240°T at 15 knots.

   Skunk "B"'s direction of relative motion and relative speed is:

   _____°T at _____ knots 162°T at 25 knots

   Skunk "B"'s course and speed is:

   _____°T at _____ knots 190°T at 33 knots

2. Find the speed in knots using the Ralston (3-minute) Rule:

Distance Traveled	Time	Speed in Knots
1250 yards	3 minutes	12.5
860 yards	3 minutes	8.6
907 yards	3 minutes	9.07
4567 yards	3 minutes	45.67
888 yards	6 minutes	4.44
1267 yards	9 minutes	4.22
15000 yards	4 minutes	11.25
3000 yards	12 minutes	7.5
3000 yards	5 minutes	18
1050 yards	10 minutes	3.15
1590 yards	36 minutes	1.33
2300 yards	10.5 minutes	6.57
1850 yards	8 minutes	6.94
5423 yards	2 minutes	8.13
3631 yards	1 minute	108.93

Name:_____

Maneuvering Board Problem Set 2

1. Use a maneuvering board, ruler, and dividers to answer the following questions:

   a. On radar, you note the following bearings and ranges for Skunk "A":

Time	Bearing	Range
0900	330°T	7000 yards
0903	336°T	6200 yards
0906	343°T	5500 yards

   Your course and speed is 000°T at 20 knots.

   Skunk "A"'s direction of relative motion and relative speed is:

   _____°T at _____ knots

   Skunk "A"'s course and speed is:

   _____°T at _____ knots

   b. On radar, you note the following bearings and ranges for Skunk "B":

Time	Bearing	Range
0915	270°T	4000 yards
0918	232°T	4000 yards
0921	207°T	5450 yards

   Your course and speed is 240°T at 15 knots.

   Skunk "B"'s direction of relative motion and relative speed is:

   _____°T at _____ knots

   Skunk "B"'s course and speed is:

   _____°T at _____ knots

2. Find the speed in knots using the Ralston (3-minute) Rule:

Distance Traveled	Time	Speed in Knots
1250 yards	3 minutes	
860 yards	3 minutes	
907 yards	3 minutes	
4567 yards	3 minutes	
888 yards	6 minutes	
1267 yards	9 minutes	
15000 yards	4 minutes	
3000 yards	12 minutes	
3000 yards	5 minutes	
1050 yards	10 minutes	
1590 yards	36 minutes	
2300 yards	10.5 minutes	
1850 yards	8 minutes	
5423 yards	2 minutes	
3631 yards	1 minute	

Name:_____

Maneuvering Board Problem Set 3

1. Use a maneuvering board, ruler, and dividers to answer the following questions:

   a. On radar, you note the following bearings and ranges for Skunk "A":

Time	Bearing	Range
1503	085°T	8000 yards
1509	086.5°T	7000 yards
1515	088°T	6000 yards

   Your course and speed is 180°T at 15 knots.

   Skunk "A"'s direction of relative motion and relative speed is:

   _____°T at _____ knots 256°T at 5 kts.

   Skunk "A"'s course and speed is:

   _____°T at _____ knots 199°T at 17.5 kts.

   b. Your ship, U.S.S. *Enterprise* (CV-6) is at the center of a squadron of ships which, together are on a course of 180°T at 15 knots. Directly in front of your ship is U.S.S. *Cushing* (DD-376). *Cushing* is patrolling a "screen sector" looking for enemy submarines that is marked out by the following points:

Point 1	200°T / 6000 yards from *Enterprise*
Point 2	200°T / 10000 yards from *Enterprise*
Point 3	160°T / 10000 yards from *Enterprise*
Point 4	160°T / 6000 yards from *Enterprise*

   What courses must *Cushing* to move from right to left and back across her sector at an actual speed of 25 knots.

   127°T and 234°T

Name:_____

Maneuvering Board Problem Set 3

1. Use a maneuvering board, ruler, and dividers to answer the following questions:

   a. On radar, you note the following bearings and ranges for Skunk "A":

Time	Bearing	Range
1503	085°T	8000 yards
1509	086.5°T	7000 yards
1515	088°T	6000 yards

   Your course and speed is 180°T at 15 knots.

   Skunk "A"'s direction of relative motion and relative speed is:

   _____°T at _____ knots

   Skunk "A"'s course and speed is:

   _____°T at _____ knots

   b. Your ship, U.S.S. *Enterprise* (CV-6) is at the center of a squadron of ships which, together are on a course of 180°T at 15 knots. Directly in front of your ship is U.S.S. *Cushing* (DD-376). *Cushing* is patrolling a "screen sector" looking for enemy submarines that is marked out by the following points:

Point 1	200°T / 6000 yards from *Enterprise*
Point 2	200°T / 10000 yards from *Enterprise*
Point 3	160°T / 10000 yards from *Enterprise*
Point 4	160°T / 6000 yards from *Enterprise*

   What courses must *Cushing* to move from right to left and back across her sector at an actual speed of 25 knots.

Name:_____

Maneuvering Board Practice Assessment

Show all work on a maneuvering board. Place answers on this sheet.

1. Use a maneuvering board, ruler, and dividers to answer the following questions:

   a. On radar, you note the following bearings and ranges for Skunk "A":

Time	Bearing	Range
1230	270°T	7000 yards
1233	247°T	6000 yards
1236	221°T	6300 yards

   Your course and speed is 300°T at 20 knots.

   Skunk "A"'s direction of relative motion and relative speed is:

   _____°T at _____ knots 149°T / 28 kts.

   Skunk "A"'s course and speed is:

   _____°T at _____ knots 194°T / 14 kts.

   b. Your ship, U.S.S. *Hornet* (CV-8) is at the center of a squadron of ships which, together are on a course of 300°T at 20 knots. Directly in front of your ship is U.S.S. *Fletcher* (DD-445). *Fletcher* is patrolling a "screen sector" looking for enemy submarines that is marked out by the following points:

Point 1	330°T / 4000 yards from *Hornet*
Point 2	330°T / 6000 yards from *Hornet*
Point 3	010°T / 6000 yards from *Hornet*
Point 4	010°T / 4000 yards from *Hornet*

   What courses must *Fletcher* to move from right to left and back across her sector at an actual speed of 25 knots in one direction and 15 knots in the other. 290°T at 25 kts. and 320°T at 15 kts.

YOU HAVE 10 MINUTES TO ANSWER EACH QUESTION

Name:_____

Maneuvering Board Practice Assessment

Show all work on a maneuvering board. Place answers on this sheet.

1. Use a maneuvering board, ruler, and dividers to answer the following questions:

   a. On radar, you note the following bearings and ranges for Skunk "A":

Time	Bearing	Range
1230	270°T	7000 yards
1233	247°T	6000 yards
1236	221°T	6300 yards

   Your course and speed is 300°T at 20 knots.

   Skunk "A"'s direction of relative motion and relative speed is:

   _____°T at _____ knots

   Skunk "A"'s course and speed is:

   _____°T at _____ knots

   b. Your ship, U.S.S. *Hornet* (CV-8) is at the center of a squadron of ships which, together are on a course of 300°T at 20 knots. Directly in front of your ship is U.S.S. *Fletcher* (DD-445). *Fletcher* is patrolling a "screen sector" looking for enemy submarines that is marked out by the following points:

Point 1	330°T / 4000 yards from *Hornet*
Point 2	330°T / 6000 yards from *Hornet*
Point 3	010°T / 6000 yards from *Hornet*
Point 4	010°T / 4000 yards from *Hornet*

   What courses must *Fletcher* to move from right to left and back across her sector at an actual speed of 25 knots in one direction and 15 knots in the other.

YOU HAVE 10 MINUTES TO ANSWER EACH QUESTION

Name:_____

Maneuvering Board Assessment I

Show all work on a maneuvering board. Place answers on this sheet.

1. Use a maneuvering board, ruler, and dividers to answer the following questions:

   a. On radar, you note the following bearings and ranges for Skunk "A":

Time	Bearing	Range
1915	170°T	7000 yards
1918	168°T	6100 yards
1921	165°T	5200 yards

   Your course and speed is 003°T at 20 knots.

   Skunk "A"'s direction of relative motion and relative speed is:

   _____°T at _____ knots 003°T / 10 kts.

   Skunk "A"'s course and speed is:

   _____°T at _____ knots 090°T / 18 kts.

   b. Your ship, U.S.S. *Lexington* (CV-2) is at the center of a squadron of ships which, together are on a course of 120°T at 20 knots. Directly in front of your ship is U.S.S. *Fletcher* (DD-445). *Fletcher* is patrolling a "screen sector" looking for enemy submarines that is marked out by the following points:

Point 1	100°T / 6000 yards from *Lexington*
Point 2	100°T / 10000 yards from *Lexington*
Point 3	140°T / 6000 yards from *Lexington*
Point 4	140°T / 10000 yards from *Lexington*

   What courses must *Fletcher* to move from right to left and back across her sector at an actual speed of 25 knots. 085°T / 155°T

YOU HAVE 10 MINUTES TO ANSWER EACH QUESTION

2. Find the speed in knots using the Ralston (3-minute) Rule:

Distance Traveled	Time	Speed in Knots
3000 yards	3 minutes	30
1050 yards	3 minutes	10.5
1590 yards	3 minutes	15.9
2300 yards	3 minutes	23
1850 yards	6 minutes	9.25
5423 yards	9 minutes	18.08
3631 yards	4 minutes	27.23
1250 yards	12 minutes	3.13
860 yards	5 minutes	5.16
907 yards	10 minutes	2.72
4567 yards	36 minutes	3.81
888 yards	10.5 minutes	2.66
1267 yards	8 minutes	4.75
15000 yards	2 minutes	225
3000 yards	1 minute	90

Name:_____

Maneuvering Board Assessment I

Show all work on a maneuvering board. Place answers on this sheet.

1. Use a maneuvering board, ruler, and dividers to answer the following questions:

   a. On radar, you note the following bearings and ranges for Skunk "A":

Time	Bearing	Range
1915	170°T	7000 yards
1918	168°T	6100 yards
1921	165°T	5200 yards

   Your course and speed is 003°T at 20 knots.

   Skunk "A"'s direction of relative motion and relative speed is:

   _____°T at _____ knots

   Skunk "A"'s course and speed is:

   _____°T at _____ knots

   b. Your ship, U.S.S. *Lexington* (CV-2) is at the center of a squadron of ships which, together are on a course of 120°T at 20 knots. Directly in front of your ship is U.S.S. *Fletcher* (DD-445). *Fletcher* is patrolling a "screen sector" looking for enemy submarines that is marked out by the following points:

Point 1	100°T / 6000 yards from *Lexington*
Point 2	100°T / 10000 yards from *Lexington*
Point 3	140°T / 6000 yards from *Lexington*
Point 4	140°T / 10000 yards from *Lexington*

   What courses must *Fletcher* to move from right to left and back across her sector at an actual speed of 25 knots.

YOU HAVE 10 MINUTES TO ANSWER EACH QUESTION

3. Find the speed in knots using the Ralston (3-minute) Rule:

Distance Traveled	Time	Speed in Knots
3000 yards	3 minutes	
1050 yards	3 minutes	
1590 yards	3 minutes	
2300 yards	3 minutes	
1850 yards	6 minutes	
5423 yards	9 minutes	
3631 yards	4 minutes	
1250 yards	12 minutes	
860 yards	5 minutes	
907 yards	10 minutes	
4567 yards	36 minutes	
888 yards	10.5 minutes	
1267 yards	8 minutes	
15000 yards	2 minutes	
3000 yards	1 minute	

Preliminary Instruction
Navigation Review

a. Latitude and Longitude:

i. Latitude:

Variables:

Latitude (La)
Observed Altitude of Sun (O)
Sun's Declination (D)

Formula:

$La = 90° - O + D$
(Sun in Northern Hemisphere)

$La = 90° - O - D$
(Sun in Southern Hemisphere)

ii. Longitude:

Variables:

Longitude: (Lo)
GMT of LAN (GMT)
Result of Subtraction (S)
Hours from Subtraction (H)
Minutes from Subtraction (M)

Formulas:

1. $S = 12{:}00 - GMT$ $(12{:}00 > GMT)$
   $S = GMT - 12{:}00$ $(12{:}00 < GMT)$

2. $Lo = H * 15° + \frac{M}{(4'per\ °)}$

b. True Bearing:

Variables:

True Bearing (TB °T)
Magnetic Bearing (M °E or °W)
Declination (D °E or °W)

Formulas:

TB °T $= \pm$M $\pm$ D $+ 360°$ (if initial result is negative.

c. Distance Traveled:

Variables:

Distance Traveled (D nm)
Speed in Knots (S nm/hr)
Time of Journey (T hrs.)

Formulas:

$$D\ nm = \left(\frac{S\ nm}{hr}\right) * T\ hrs.$$

d. Fuel Burned:

Variables:

Fuel Burned on Journey (F gal.)
Gallons Burned per NM (G gal.)
Distance Traveled (D nm)

Formulas:

$$F\ gal. = \left(\frac{G\ gal}{nm}\right) * D\ nm$$

e. Percentage of Fuel Burned:

Variables:

Percentage of Fuel Burned (B)
Fuel Burned on Journey (F gal.)
Total Fuel Carried (T gal.)

Formulas:

$$B = \frac{F\ gal.}{T\ gal.}$$

f. Percentage of Fuel Remaining:

Variables:

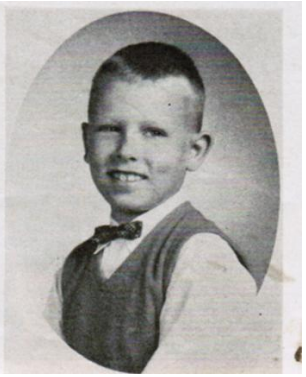
Percentage of Fuel Remaining (P)
% Fuel Onboard fm Previous Day (PD)
Percentage of Fuel Burned Today (B)

Formulas:

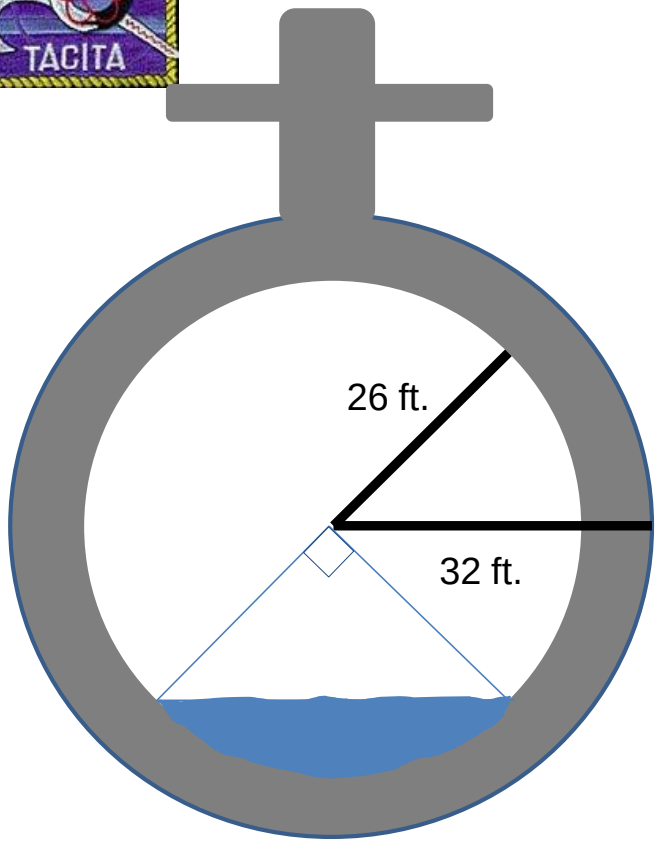
$$P = PD - B$$

Loss of U. S. S. Thresher

April 10th, 1963



Loss of U. S. S. Thresher



1. If the reactor / engine compartment is 100 ft. long, what is the volume of the flooded portion?

2. How many gallons of water flooded into the compartment? (7.48 gallons per cu. ft.)

3. What was the added weight to the submarine? (8.35 gallons to one pound)

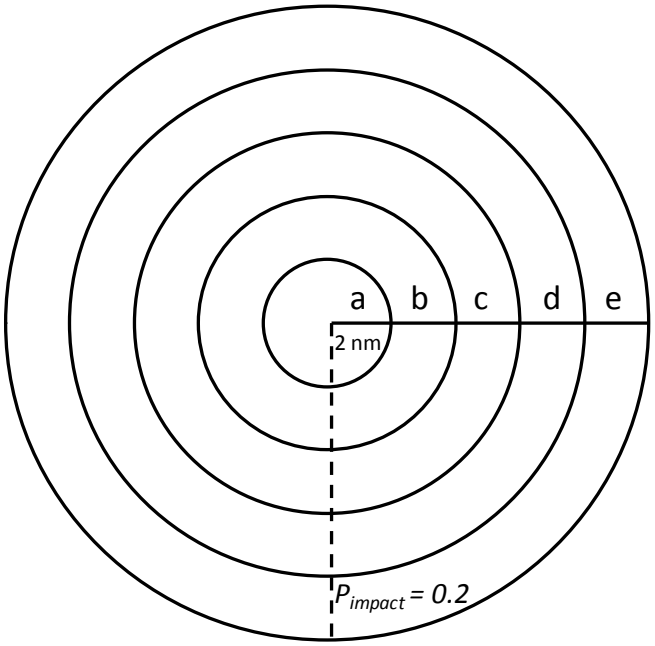
Name: _____

Preliminary Instruction: Practical Problems Involving Circles
Solve All Problems on Separate Sheets of Paper

1. A test missile is fired from the Pacific Missile Test Center at Edwards Air Force Base in California to an impact area in the Pacific Ocean. The impact area depicted below is a circle 20 nautical miles (nm) in diameter.

   - There are five circular regions in the impact area, labeled *a, b, c, d, e*. Each is 2 (nm) in width.

   - The probability that the missile will impact in any one of the five circular regions (P_{impact}) is 20% (0.20). Therefore, the probability that the missile will impact somewhere in the impact area is $P_{impact}(a) + P_{impact}(b) + P_{impact}(c) + P_{impact}(d) + P_{impact}(e) = 0.20 + 0.20 + 0.20 + 0.20 + 0.20 = 1.00 = 100\%$.

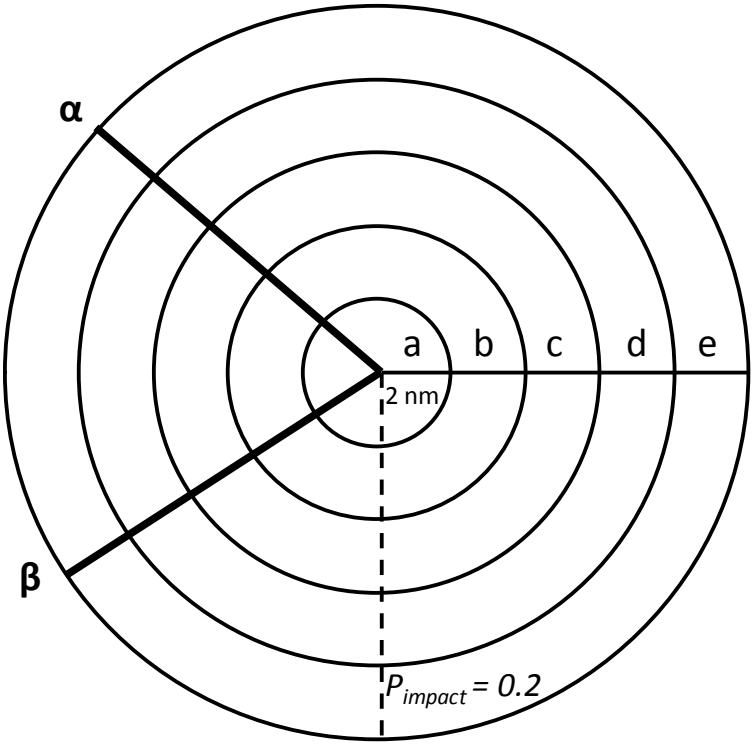


   a. What is the total impact area?

   b. What is the area of region c?

   c. What is the probability that the missile will impact no closer than 6 nm to the center of the impact area?

2. The measure of the central angle intercepting the minor arc αβ is 85°.



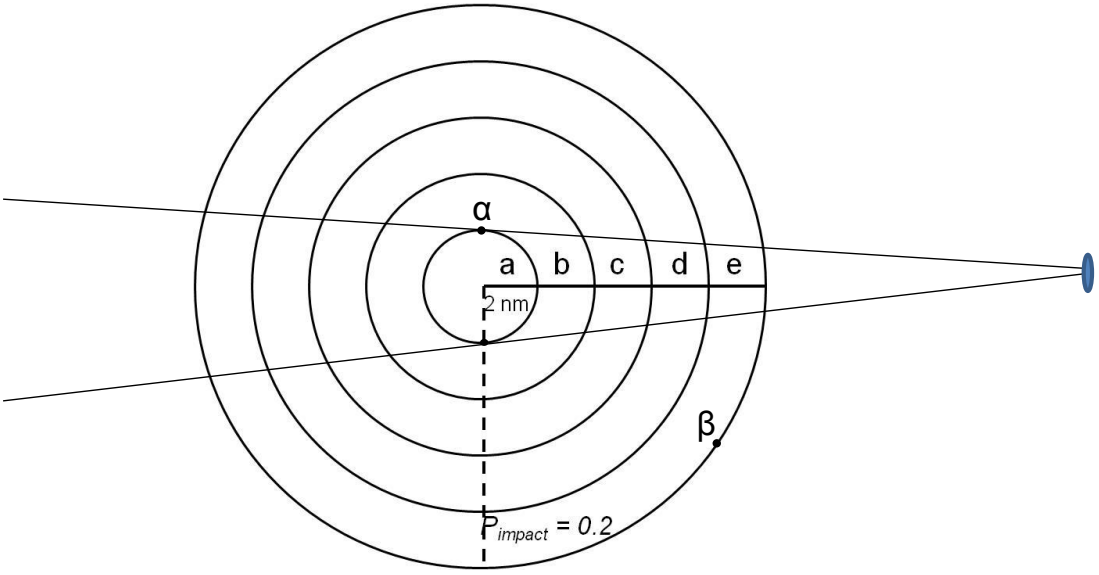
a. What is the length of minor arc αβ?

b. What is the probability that the missile will impact in the region between the two radii that intercept minor arc αβ?

c. What is the probability that the missile will impact in the region between the two radii that intercept minor arc αβ no closer than 6 nm from the center?

Preliminary Instruction: Practical Problems Involving Circles
Solve All Problems on Separate Sheets of Paper

A Chinese surveillance ship is sitting outside of the impact area using radar to observe the missile's impact.



1. If the measures of the two intercepted arcs on the outer edge of region *e* are 25° and 20° respectively, what is the measure of the angle formed by the radar beam?

2. If the radar beam covers one fifth of the impact area every second, what is the probability that the Chinese surveillance ship will see the missile just as it hits the ocean?

3. If the length of the radar beam from the Chinese surveillance ship to point α is 20 nm, what is the distance of the Chinese surveillance ship from the center of the impact area?

4. If the Chinese surveillance ship were to move from its present position to the edge of the impact area at point β and shine its radar beam toward the center of the impact area, what would be the measure and arc length of the arc intercepted on the outer edge of region *e*?

Name: _____

9th Grade Final Project Pre – Assessment

Show all work on separate sheets of paper attached to this one.

1. **Data Analysis and Linear Modeling.**

   A. Enter the following data into Microsoft Excel or Open Office Spreadsheet.
   B. Graph the data as a scatter plot, labeling the graph and both axes.
   C. Fit a linear function to the graph.
   D. Display the linear equation and the R^2 value on the graph.
   E. Predict the value of "y" when $x = 2015$.
   F. Print and attach the graph with equation, R^2 value, and answer to "E" included.

x = Year	y = Altitude (in km)
1998	400
1999	380
2000	360
2001	380
2002	390
2003	380
2004	360
2005	350
2006	340
2007	330
2008	340
2009	360
2010	340
2011	340

2. **Systems of Equations: Algebra students only should answer this question.**

   A. Enter the following data into Microsoft Excel or Open Office Spreadsheet.
   B. Graph both data sets as a scatter plot.
   C. Fit linear functions to the two graphs.
   D. Display the linear equations on the graph.

E. The two linear equations are a system of equations. Rewrite them and then solve using any method with which you are familiar.

F. Attach the graph to this document.

x	y1	y2
-10	-15	34
-9	-13	31
-8	-11	28
-7	-9	25
-6	-7	22
-5	-5	19
-4	-3	16
-3	-1	13
-2	1	10
-1	3	7
0	5	4
1	7	1
2	9	-2
3	11	-5
4	13	-8
5	15	-11
6	17	-14
7	19	-17
8	21	-20
9	23	-23
10	25	-26

Solution to the system:
x = _____
y = _____

3. **Geometry and Scaling.**

A. You want to draw a scaled picture of a ship which has an actual length of 700 feet. The picture will be 36 inches in length. Determine the scale factor to convert all dimensions of the ship from actual size to your drawing size.

Ans.: _____

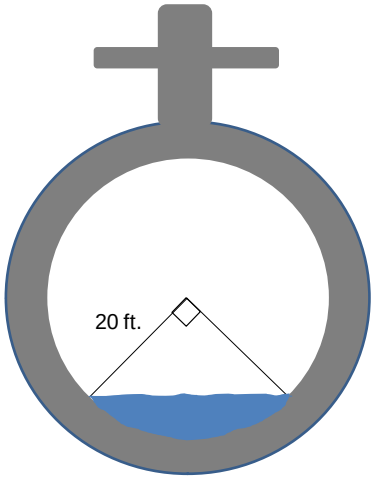
B. **Geometry students only should answer this question.** You want to fill a container box which has dimensions of 20 feet by 8 feet by 8 feet with

eight identical cylinders which are 8 feet in height and exactly fill the box (i.e. no usable space is left over). What is the surface area and volume of one of the cylinders?

Surface area: _____ Volume: _____

C. **Geometry students only should answer this question.**

i. The flooded compartment of the submarine depicted below is 50 feet in length. Find the volume of the flooded portion.



Volume = _____

4. **Navigation.**

A. From the following information, find the ship's 12:00 noon latitude and longitude.

Date	GMT of LAN	Sun's Altitude	Sun's Declination	Latitude	Longitude
November 15th	1630	40° 23.15'	23° 08' S		

B. U.S.S. *Rentz* travelled 450 nm in 24 hours on one engine.

i. At what speed was she travelling? _____

ii. How many gallons of fuel did she burn? _____